THE

ELECTRICAL REVIEW.

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"ELECTRICAL REVIEW."

Vol. LI.] CONTENTS: October 3, 1902. [No. 1,297.

	Page
Electricity Supply	565
Electrical Plant at the Düsseldorf Exhibition (*illustrated*) (*continued*)	567
The Length of the Tether	568
Double Current Generators and Rotary Converters	569
The Electrical Trade of the United States	571
The Wolverhampton Exhibition (*illustrated*) (*continued*) ...	572
The Difficulties that Students of Electrical Engineering Meet With	573
Correspondence:—	
Sales	574
A Question of Trade Etiquette	575
Electric Hoists	576
Mechanical Engineers for Electric Generating Stations	576
The Old and the New Electrical Theory (*continued*)	576
Feed Waters: Their Action on Boilers and the Testing of Waters	578
The Experiences of a Telegraph Engineer in Perak State, 1898—1901 (*illustrated*)	579
The Production of Mixed Carbides of Manganese and Calcium	581
Business Notes	581
The Making of a Dynamo (*illustrated*)	583
City Notes	593
Traffic Receipts	594
Stocks and Shares	594
Share List of Electrical Companies	595
Market Quotations	596
The Application of Electric Power in the Iron and Steel Industries (*continued*)	597
British Association, Belfast, 1902:—	
On the Prevention of Smoke	598
Magnetic Detectors in Space Telegraphy (*illustrated*) ...	599
Some Novelties in Electrical Apparatus (*illustrated*) ...	600
Electric Response in Animal, Vegetable and Metal ...	601
A CO_2 Recorder (*illustrated*)	601
Dr. Muirhead's New Mode of Transmission and Relay for Cables (*illustrated*)	602
New Patents	604
Abstracts of Published Specifications	604

THE

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ELECTRICITY SUPPLY.

THE Parliamentary returns relating to electricity supply undertakings in the United Kingdom could hardly have appeared at a more appropriate moment. They are belated, it is true, as they apply to a period which ended somewhere about 18 months ago, and their value is, on that ground, somewhat lessened; but they come at a time when public interest happens to be excited, as never before, on the point of municipal electrical trading. The *Times* disclosures, the Hon. R. P. Porter's British Association address, the anti-municipal tramways agitation at Birmingham, and also, may we say, our own occasional articles emphasising the necessity for allowing full depreciation and interest and sinking fund charges before "declaring" profits, have, as a most fitting climax, the publication of these figures, showing what enormous benefits the ratepayers of British towns and districts are *not* obtaining by the public operation of electric lighting stations.

The figures were given in abstract form on p. 552 of our last issue, and we wish that we could spare a dozen or so of the ELECTRICAL REVIEW pages to reprint the tables in full, so convincing are they of the accuracy of the line that we ourselves have felt constrained to take up during the past year or two. We would, however, here interpolate advice to all who take any interest in the present position of electricity supply, whether their views be in favour of one side or the other, or even of neither, to procure copies of these two three-halfpenny returns.

While figures generally form very dry material, they are also declared to be very accommodating, and can be made to prove anything. They have been used long enough already to demonstrate before the eyes of local ratepayers, by a cooking process, that a profit is being earned, though the contrary is the fact. Now the Board of Trade has compiled from the official accounts filed by the different undertakers for the year 1900 (ended in many cases March or May, 1901) a set of returns which tells a very different tale, and puts the matter in a more correct form.

The returns relating to companies show that the net profit amounted to over £321,000, and here, of course, it is only right to mention that 16 out of the total of 63 companies (not 47, as stated last week) are carrying on operations in the London district, where the conditions are generally exceptionally favourable for electricity supply business; of these 16, four show losses, and for 12 a total net profit of £258,995 is returned. The capital expended amounts to £8,475,377. A simple application of figures and school-boy arithmetical calculations will soon show that the average percentage of profit for these 16 companies—money-grubbing companies, says the red-hot municipal trader—is only 3·8 per cent. This is the glorious average of profit—and we presume it is fair to take the average—that is now being earned by private capital

invested in electric lighting companies in the London areas. There are some of them working, as we have said, at a loss, and on the other hand, some of them have been earning good dividends of 12 and 14½ per cent. for several years past. We feel that no one with any sense of equity will grudge a good dividend to those who have pioneered the supply of electricity in this country; we mean investors who "went into the thing" when new ground had to be cut and enormous difficulties faced, and, may we say it, whose early difficulties and successes paved the way for municipal authorities to act for themselves in electricity supply.

The total capital expenditure of company supply for the whole kingdom is close upon 11 millions sterling, and we find the following totals in other columns:—Reserve fund, £90,484 (+ £369 interest) added during the year; depreciation fund £91,678 (+ £477 interest) added during the same period.

Turning to the municipal figures and considering them in the same way, we find that the total capital expenditure has been about 15 millions sterling, and the amount placed to reserve fund during the year is £30,332 (+ £3,357 interest). Corporations have paid £397,579 for interest on loans, showing an average rate of 2⅞ per cent., and to sinking fund £282,726 (+ £6,110 interest). There is no municipal depreciation fund column as such, and the allowances therefor, if and where made, are presumably to be found in the sinking and reserve funds, except in the case of Aberdeen, where the net surplus of £2,673 is marked "carried to depreciation," and also in the case of Rothesay (public lighting only), where a surplus of £120 is disposed of in a similar manner. The surplus columns for municipal works, for some reason or another, are not totalled out in the document before us, but we find them to amount to £45,254, and the losses to £102,931! Probably the Board of Trade takes the sensible view that the surpluses are hardly worth mentioning, as they would be swept clean off the slate if proper depreciation allowances were made.

We leave the figures with the reader to make what deductions he may therefrom.

Among other points noticed in the course of an examination of these returns is the fact that, where companies are in possession of the field, the receipts from public electric lighting are very small indeed, but in the case of some of the municipal supplies public lighting brings in nearly as much as, and in some instances even more than, "the sale of energy and other receipts."

Let us quote a few instances of the kind. At Barking public lighting receipts are given as £1,744, and the other receipts £2,152 (the net loss here is £1,006, after allowing for interest and sinking fund)*; at Cheltenham the figures are £4,370 from public lighting and £5,716 from other receipts, with the result that there is a loss of £3,638, after providing for interest and sinking fund. At King's Lynn the public lighting brought in £1,899, and the private supply only £2,002, and the loss is set down at £1,068. At Poplar the figures are—public lighting £1,730, and private supply only £1,283, with a loss of £1,268. At Rathmines and Rathgar the figures are—£1,334 and £790, with a loss of £820; and at Watford £2,369 and £1,876, with a loss of £1,355. Curiously enough, when we turn to the large and important city of Sheffield we find nothing whatever allowed for public lighting, yet the private supply brings in £41,939, and there is a net surplus shown of £4,048. At Manchester, where public electric lighting is very limited (£363), and the sale of energy for 1900 brought in £101,525, the surplus is £3,516. These figures would almost seem to show that so far as they are regarded merely as an advertisement of the undertaking, street electric lamps do not bring much grist to the mill. We grant, however, that in such business and industrial centres as Manchester and Sheffield electricity supply needs little advertising.

Far be it from us, who are so intimately concerned with the progress of the electric lighting industry, to under-value the vast improvement that street electric lighting effects in practically every locality where it is adopted on an extensive scale. But the cost of its maintenance should appear in the accounts of different committees at a reasonable figure. Public arc lighting ought, as a matter of fact, to be a help to a station instead of weighing it down by charging energy and maintenance at too low a figure per lamp per annum. It should be looked upon as a borough improvement, and paid for as such.

Is it not a little curious that public lighting is far more extensively employed where municipalities supply themselves than where companies are the undertakers? Have the Jews still no dealings with the Samaritans?

Many other matters of interest in these returns might be discussed, such, for instance, as the rates of charging by companies *versus* municipalities, and the excess of capital expended over the amount of loans authorised to municipalities, but the space at our command is limited. An important phase of the municipal loans question is discussed on another page in this issue.

* Since writing the above, we learn that the L.G.B. insists on the Barking Council wiping off the loss on its electricity works in the next rate, instead of allowing it to accumulate further.

Secret Commission.

A CARD has come into our possession which was recently left at the office of a firm of consulting engineers. The face of the card bears the name of an electrical contracting firm, and that of the representative who left the eloquent little missive; on the back, in addition to the name of a member of the firm of consulting engineers, who is styled "architect," are pencilled the words—"*25 per cent. commission on all contracts.*"

It is an unfortunate fact that there are black sheep in every fold, and we knew that the electrical trade was not blameless in this respect; but the fact that such a scandalous proposition should be put before a firm of engineers of repute is a shocking revelation. The natural inference—that the method had been successfully adopted in other cases—is too painful for consideration. It is, of course, obvious that a firm of contractors which is compelled to descend to such depths of infamy in order to get work cannot be established on the solid basis of sound workmanship and materials; moreover, it may perpetrate a vast amount of harm in other ways.

We must confess, with feelings of shame, that there are men in the ranks of consulting electrical engineers who are not above taking 5 per cent. from the contractors as well as from their clients, the double commission being, of course, unknown to the latter. It may be argued that the consultant has both parties for his clients, and that the contractor should pay him for his services, as well as the purchaser; but the weakness of this argument is obvious, for the latter, in reality, pays both fees and he is defrauded of the second fee. The contractors who support these practices are as blameworthy as the engineers who impose them.

It is particularly noteworthy that the card mentioned above styled one of the consulting engineers as "*architect.*" We have no wish to attack an honourable profession, but it has come to our knowledge on more than one occasion that architects in whose hands lay the placing of important electrical contracts, have refused to deal with certain electrical firms unless a commission were secretly set aside for them in the sum named in the tender. It is pitiful that such things should happen. The sooner the acceptance and tender of secret commissions is made the subject of severe legislation, with a view to its suppression, the better it will be for all parties concerned.

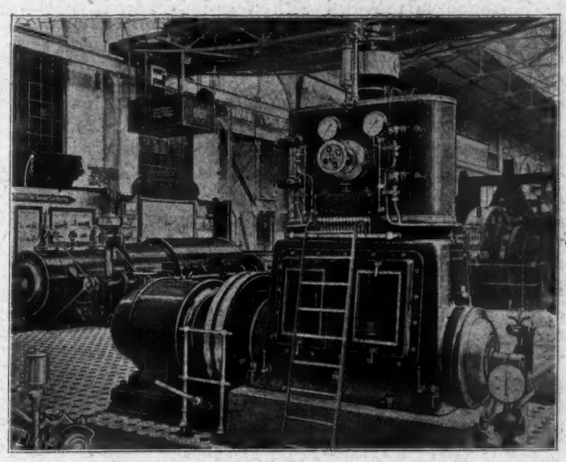
ELECTRICAL PLANT AT THE DÜSSELDORF EXHIBITION.

The Helios Elektricitäts A.-G., of Köln-Ehrenfeld, has a comprehensive exhibit, the principal feature of which is a three-phase alternator of imposing dimensions, direct driven by a horizontal engine built by the Maschinenfabrik Grevenbroich, of Grevenbroich. The normal output of the alternator is 2,000 kw. at 2,000 volts, 72 r.p.m., 50 cycles per second. The rotating field magnet is of the fly-wheel type, having an over-all diameter of 8 m. The wheel is of cast-iron, in four parts, and weighs 60,000 kg. without the poles and coils; the section of the rim is **U**-shaped, so as to have the maximum stiffness against centrifugal force, and it is carried by 12 double arms. The hub is of large diameter, to reduce the length of the arms, and thus add to their stiffness; the arms are secured to the hub by means of two shrunk rings and 12 bolts, and the rim is joined up with bolts, keys and shrunk rings, the section of the rim being especially favourable for this purpose. The poles are of cast-steel, 84 in number; they are let into the rim and secured by bolts.

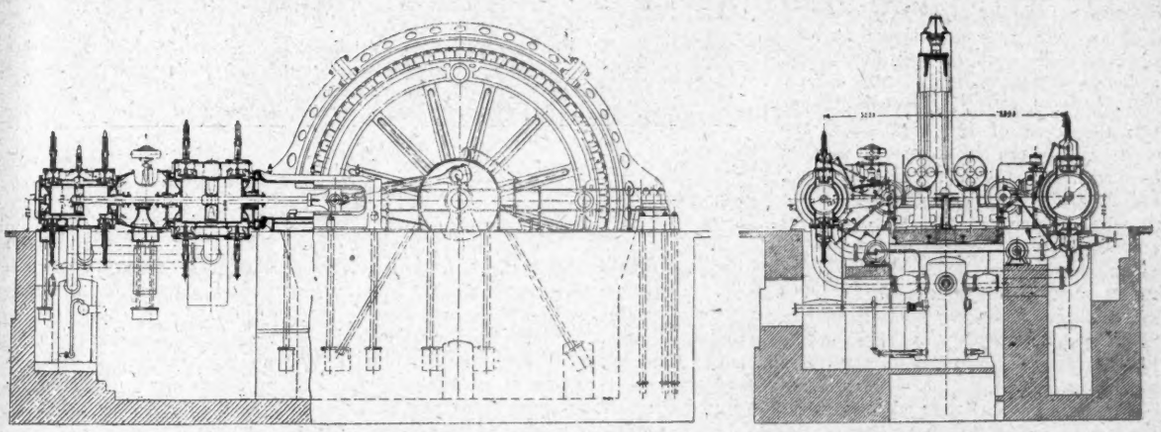
The coils are wound with bare copper strip, which is polished bright on the external surface, giving a very handsome finish; the convolutions are insulated from one another with paper, and from the core with pressspahn.

The armature is wound on the Scott system, which enables it to work as a single-phase or three-phase machine as desired; in the Exhibition it is connected with the three-phase circuits, but it will eventually be installed in a single-phase station. In either case the output is 2,000 kw., but a combined output of 1,500 kw. three-phase and 1,000 kw. single-phase can be obtained from it if desired.

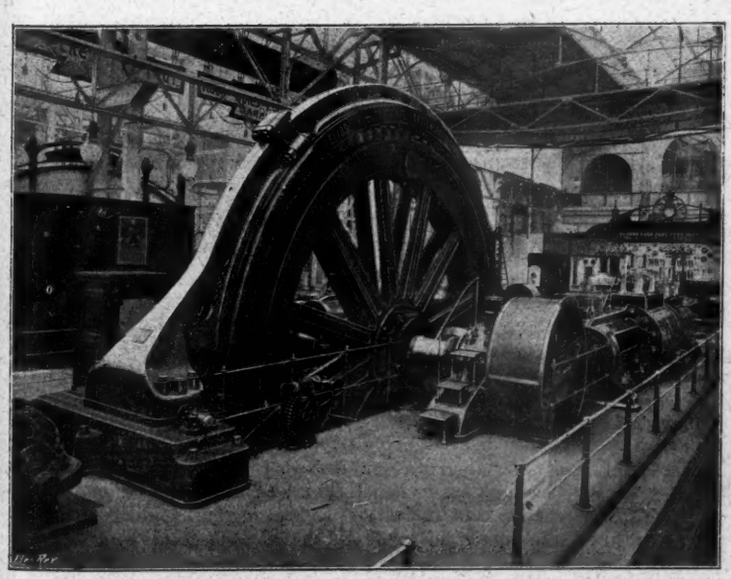
The exciting current is obtained from the Exhibition mains by means of a motor-generator, which reduces the pressure from 230 volts to 140—150 volts. The switchgear is located in the foundations, where high pressure automatic circuit-breakers and the starting gear for the motor-generator are provided. The exciting current is controlled from the main switchboard of the Exhibition, which may be seen in the background. All the necessary electrical measuring instruments, as well as the steam pressure and vacuum gauges, are mounted on pillars near the starting platform of the engine.



Soest High-Speed Enclosed Steam Dynamo.



Cross-Sections of Helios-Grevenbroich Steam Alternator.



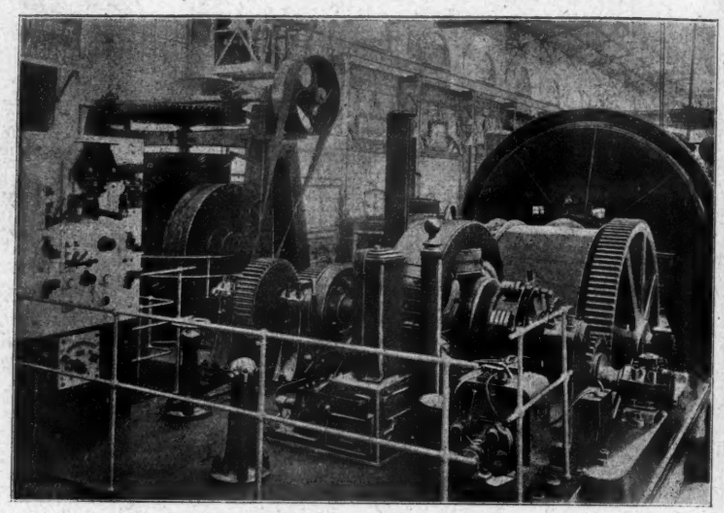
Helios-Grevenbroich Steam Alternator.

The latter is of the twin tandem compound type, with four cylinders and two cranks, between which the magnet wheel is carried. The cylinders are 725 and 1,100 mm. in diameter, with a stroke of 1,300 mm. The rated output is 2,000 B.H.P. with a steam pressure of 150 lbs. per sq. in., cut off at ¼ stroke, and condensing. The crankshaft is of steel, bored throughout, with wrought-iron cranks shrunk on, and provided with balance weights. The crank-pins are of nickel steel. The guides are bored out, and are supported from end to end. The piston rods are of steel, 6¼ in. in diameter, and are carried on spring-supported bearings between the cylinders. All the cylinders and receivers are jacketed with live steam. The high-pressure cylinders are fitted with the Grevenbroich positively-closing valve gear, which is simple in con-

struction and has been used for many years, while the low-pressure valve gear is worked by cams. The shafts which operate these gears are fitted with expansion couplings in the middle to compensate for the expansion of the cylinders. Each engine is provided with a spring-loaded adjustable governor and emergency stop-lever. The lubricating system is very complete, and provides for continuous running, without waste of oil. Either engine may be run alone in case of need.

The Maschinenfabrik Grevenbroich also exhibits its patent water-purifying apparatus in the main boiler house.

Messrs. Louis Soest & Co., of Reisholz, have a large number of exhibits at their stand. Of these we illustrate a vertical compound high-speed engine of the enclosed type, and an electrical hauling plant. The engine has two cranks at 180°, and runs at 525 revolutions per minute, giving 100 to 150 H.P., with a steam pressure of 150 lbs. abs. per square inch. The cylinders are 250 and 375 mm. in diameter, with a stroke of 200 mm. The valve gear is of an unusual type; the main valve rotates, distributing the steam to both cylinders, while permitting of the independent adjustment of the lead and compression for each cylinder. A reciprocating valve, controlled by the governor, regulates the cut-off in the high-pressure cylinder in such a way that the steam is both throttled and cut off early on light loads, while it is freely admitted and cut off late on full load. The valve rotates at half the speed of the engine, and the space within the valve is used as a receiver. Large bearings are provided, as well as a very complete system of gravity lubrication. The engine is coupled to a Lahmeyer dynamo.



Soest Electrical Hauling Machine.

The hauling gear shown by the firm has two rope-drums 2,200 mm. in diameter and 950 mm. wide. These are driven through double-reduction spur gearing by a motor, running at 300 revolutions per minute, and rated at 100 H.P. at 440 volts. The machine is designed for a load of 1,200 kg. at 3 m. per second.

Messrs. Louis Soest also show a 350-H.P. horizontal tandem compound steam engine driving a Lahmeyer dynamo; a gas engine of the same power for dynamo-driving; a vertical engine of 200 H.P., and a number of machines for stone-breaking, grinding, &c.

(*To be continued.*)

THE LENGTH OF THE TETHER.

Local authorities agitate for more time to repay their loans, and to put off the evil day for commencing their sinking funds as long as possible, but a more serious question looms in the future, viz., when will the security for the borrowed money be exhausted?

As this is a matter of considerable importance in view of the fact that municipal indebtedness is increasing in a much greater ratio than the value of the rates which provide the security, it is of interest to examine the regulations as to the exercise of borrowing powers provided for under Clause 234 of the Public Health Act, 1875. Sub-section 2 of the clause is as follows:—"The sum borrowed shall not at any time exceed, with the balances of all the outstanding loans contracted by the local authority under the Sanitary Acts and this Act, in the whole the assessable value for two years of the premises assessable within the district, in respect of which such money may be borrowed."

The principle of this clause constitutes *a limit to the borrowing powers*, and unless property is assessed not upon its intrinsic value, but for the purpose of increasing the rateable value so as to add to the security available for loans, a time must come when the length of the tether will have been reached, and fresh loans become practically impossible.

During the last 25 years the rateable value has increased less than 30 per cent., while local indebtedness has trebled, and it is obvious that if this proportion continues, either rates must be raised to an extent which will crush the ratepayers, or further borrowing cease.

It is unreasonable to suppose that there is no legitimate limit to municipal enterprise. It is, of course, true that in improving the attractiveness of a town prosperity is promoted, property increased in value, and the drainage, open spaces, public buildings, sea fronts, piers, markets, and all that constitutes the enterprising development of the locality can thereby be paid for by the rates within a fairly adjusted period, but even in this respect it is necessary to exercise caution, and not to calculate upon a too rapid fruition, but to cut the coat according to the cloth.

That this cautious spirit does not exist in a large number of our towns is evident, as they are not content with the exercise of that praiseworthy enterprise which is in itself quite sufficient to tax all the resources of the district, but by rushing into speculative undertakings, involving enormous financial responsibilities, they are increasing the rates to an extent which must handicap the trading community, and ultimately drive it away.

It is high time that the ratepayers should be supplied with exact information as to the financial position of the towns, by the issue of accounts certified by Government auditors, which shall show clearly the position of the various loans.

Who can understand by the accounts at present available what the value is of the security which represents the indebtedness of the town for their speculative undertakings? A loan is obtained for the purpose of carrying out an undertaking, such, for example, as a tramway or electric supply works; but what is there in the accounts to show the amount repayable by sinking fund every year, so that it can be seen whether the amount set aside for the purpose is in accordance with the terms of the loan, and what is the value of the asset representing the expenditure incurred upon it.

Without such precise data it is impossible for the public to know the exact financial position of the municipality; let us take a case as an illustration, and we select at random the electric lighting accounts to March 25th last of the Corporation of Sheffield.

The total expenditure upon the undertaking at the period named amounted to £538,502, and the amount provided for sinking fund £5,782, or, say, 1·07 per cent.; but there is nothing to show how this very small percentage carries out the terms of the various loans, aggregating more than half a million of money.

Then, again, there is no statement of the value of the plant representing the money spent upon it; for although maintained by an expenditure of £2,920, out of revenue, or, say, about ½ per cent. ('54), it is obvious that the actual

value must have depreciated by about £16,000, or nearly treble the amount, called a surplus, for the year.

To make the accounts thoroughly intelligible, they should contain a statement of the position of *each* loan, showing the amount, term for which it was borrowed, interest, annual sinking fund, and value of plant after due allowance for depreciation, payments out of fresh loans for renewals being specified, when they have become necessary through the revenue account being insufficient to cover such replacements of worn out or obsolete plant.

With such data it would be possible to understand the actual results of the trading, and to prove whether it is profitable or not; whereas under the existing systems, the public are deceived if they accept, without investigation, such a statement as that presented in the Sheffield accounts of an alleged surplus of £5,604.

Whatever views may be held on the question of municipal trading—*versus* private enterprise—there ought not to be any difference of opinion as to the preparation of municipal accounts in a form which clearly indicates the exact results.

The difference in the forms of account issued by the Board of Trade in connection with electric lighting undertakings for local authorities and companies, is answerable probably for the mistaken views of the majority of the municipalities with regard to a provision for depreciation. In the case of companies working under provisional orders depreciation is provided for, and the accounts subjected to a Board of Trade audit; but, with the local authorities, neither of these conditions apply, and hence the defective character of the accounts.

Because a company has a permanent capital, and the municipalities provide the same capital by means of a series of loans, it can have no bearing upon the ultimate result of the trading, which should be clearly shown in the accounts.

Without a proper system of accounts based upon the principles we have indicated, it will be difficult, presently, to ascertain what security the local authorities have to offer for further loans.

If the value of the assets representing the total amount of the outstanding loans is less by the action of wearing out, or other causes, than the original cost to be defrayed by the amounts borrowed, the difference should be taken into account in estimating the liabilities of the town when the Local Government Board inquire into the sufficiency of the security before granting fresh loans.

All these considerations suggest serious inquiry on the part of local authorities and of the Government departments, with whom rest the necessary consents, before embarking upon undertakings which, when once entered upon, can only be carried on with increased capital, whether profitably employed or otherwise, or abandoned at a heavy sacrifice.

Security for loans will not last for ever; it will be a serious matter when municipalities come to the end of their tether, and capitalists fight shy of such investments.

The time is, perhaps, nearer than some suppose, when bankers will hesitate to allow overdrafts, and the Local Authorities be seriously embarrassed in consequence.

DOUBLE CURRENT GENERATORS AND ROTARY CONVERTERS.

By SYDNEY WOODFIELD.

The paper on "Double Current Generators," read before the Incorporated Municipal Electrical Association, has aroused widespread interest in this class of machines. That they are not new is well known, but so far they have been little used in this country, as there was no necessity for them, owing to the limited distance of transmission required for railway work. For lighting and power work alone, there should be absolutely no demand for them, as both lighting and power work can be economically carried out from a three-phase four-wire network with many advantages, and the system should become universal in a few years. At present, however, with traction, the direct current series motor holds the field, but in the writer's opinion a few years will see the single-phase non-synchronous motor supersede the series motor; a system on the lines of Arnold's being used. However that may be, there is a considerable prejudice against double current generators, just as there was with rotary converters. Even at this stage of the art one is continually hearing that converters are difficult to start and synchronise, and that there is sure to be difficulty in operation due to hunting. These difficulties are, as everyone knows who has had the practical running of such machines, purely imaginary with present day machinery, and there should be no trouble from this latter cause provided the system is carefully designed, and the engines accurately balanced and fitted with dash pots in order to make the governors insensitive to small rapid fluctuations. The starting up and synchronising of a rotary is extremely simple and does not demand any expert knowledge. A method coming more and more into use, is starting up the converter by means of a small induction motor bolted to the bearing pedestal of the rotary; the rotor of the induction motor is fixed on to an extension of the rotary shaft projecting beyond the bearing. The induction motor has a smaller number of poles than the rotary, in order that for the same frequency it may run at a higher speed. When the motor is started, by simply throwing in the switch from the low tension side of the transformer to the stator winding, the rotary is run up to a speed somewhat higher than the synchronous speed of the converter; the field switch of the converter being closed, it immediately excites itself, and the synchronous speed may be obtained by loading one phase of the machine through a rheostat. In practice, however, it will be found that the voltage and speed can be adjusted sufficiently accurately by means of the field rheostat without having recourse to the loading rheostat, and when the synchronous speed and approximate voltage are obtained, the converter may be thrown in circuit. A converter may be used under the following circumstances, provided the necessary adjuncts are forthcoming:—

1. To convert alternating to continuous current.
2. To convert continuous current to alternating.
3. To convert alternating of one phase to that of another phase.
4. To convert according to (1), (2) or (3), and give off mechanical power at the same time.
5. To receive either continuous or alternating power from a distant source, together with mechanical power, and to give out either continuous or alternating power as the case may be.
6. To give both alternating and continuous power at the same time when driven by mechanical power.

No. 1 is the ordinary method of running for transmission to sub-stations, and is in use on the Glasgow, Middlesbro', London United, and Central London systems.

No. 2 is used when a station generates only continuous currents, and it is required to transmit to distant sub-stations; in this case, the low tension current from the slip rings is transformed up by means of raising transformers. This system was lately used by the London United Tramways Company, and as set forth below, separate excitation of the converter is necessary in this case.

No. 3 is seldom used, although quite practicable, a "frequency changer" being more commonly used. This machine consists simply of a synchronous motor driving an induction motor backwards, in case of conversion from low to high frequency. The low frequency current is led into the stator winding and the high frequency current is taken from the rotor by means of slip rings. The frequency of the slip ring currents will depend on the speed of the rotor for a fixed number of poles and is the algebraic sum of the rotor and stator frequencies.

No. 4 is extensively used for driving boosters, &c.; all the Glasgow converters drive negative boosters for the rail returns.

No. 5 is rarely, if ever, used in commercial working, although it is used in the test shops at some manufactories.

No. 6 is coming into vogue in this country, chiefly for traction; it is used largely in America for both traction and lighting.

In the present article we shall deal chiefly with No. 6, or the so-called double current generator, a machine of considerable value in the present stage of the art of electric railroading, and one, from all appearances, that has a considerable future before it. The chief advantage of this type of machine in supplying current to railroads, lies in the fact

that the load is automatically shifted from one side of the machine to the other, without altering to any large extent the efficiency, whereas in the case of an alternator and continuous current machine driven from one engine, while the efficiency of one machine near full load is high, the other machine is running at a very poor efficiency. A so-called disadvantage brought forth is that the cost is very high; this is not so in fairly high speed sizes with low frequency, since the number of poles is practically the same for continuous and alternate current machines of the same size and speed; erroneous ideas in this respect are brought about by taking American and Continental machines as criterions, where, of course, low speed engines are universal.

Another great point in favour of the use of these machines lies in the fact that spares are cut down to a minimum, thus reducing capital cost.

In a polyphase rotary converter the armature reaction is the resulting effect of the armature reaction of the machine as a synchronous motor and also as a direct current generator. As the brushes are set on the neutral positions in the converter, the continuous current armature reaction is a quarter period behind the field flux. In a synchronous motor the reaction due to the energy component of the current is a quarter period ahead of the field flux, thus the resulting armature reaction in a converter is equal to zero.

As the armature reactions cancel each other, we have only (1) the reaction of the energy current required to rotate the armature; (2) the reaction due to the wattless component of the alternating current; (3) an almost negligible effect of an oscillating nature, of three times the frequency in a three-phase machine, this effect is extremely small owing to the damping of the oscillations due to the field spools, which act in a similar manner to the short-circuited coil often put around the field spools to prevent hunting. If the rotary is giving out mechanical power, the alternating current is increased, and is greater than the corresponding value of the continuous current output, by the amount of current required to give out the mechanical power, and therefore the armature reactions do not cancel each other, the alternating current reaction being greater, in a similar manner the heating of the armature is also greater. In a double current generator the alternating and continuous currents are not in opposition, but in a similar direction, and therefore the armature reaction is due to the sum of the alternating and continuous currents, it being immaterial as to the proportions of the two currents. Hence we see that in a rotary converter the output is limited only by the "commutation," and owing to the absence of distortion this limit is far in excess of that obtained in a direct current generator. In a double current generator, however, the limit is determined by the armature heating and by the field distortion, since the armature conductors carry the sum of the two currents, and the armature reaction is due to the sum of both currents. Since the field is distorted by the armature reaction, the brushes will require to be shifted from the neutral position in order to obtain sparkless commutation. Again, if the alternating current is lagging it will exert a strong demagnetising effect on the fields, and the greater the angle of lag, the greater becomes the demagnetising effect, and this may go on to such an extent as to cause the machine to entirely lose its excitation. In a similar manner an "inverted converter," that is, a machine receiving direct current and converting to alternating current, will have a frequency depending on the phase relation of current and potential; thus with lagging currents the field excitation is weakened and the converter speeds up, increasing the frequency, the increase in frequency again increasing the lag and consequently speed, and this goes on until finally the machine gets entirely out of control. On the other hand, a leading current will increase the field excitation, causing the converter to speed down, thus decreasing the frequency. Hence an inverted converter is preferably separately excited, and for a similar reason it is often preferable to separately excite double current generators, depending on the work they are required to perform. It is clear that a double-current generator must be designed to give the desired frequency with a given speed—that is, the number of poles is fixed—for this reason a low frequency, which is chiefly used in power work, comes in conveniently. Another point which also fits in extremely well is the use of high-speed engines, since for a given frequency the higher the speed the less is the number of poles. In a low speed machine, in order to obtain the desired frequency, a large number of poles would be required, probably two or more times the number required for a good continuous current machine, and, in order to prevent the poles becoming crowded, the diameter of the field frame would have to be considerably increased, which means a large diameter of armature and commutator. Again, the poles being narrower than in a continuous current machine, the number of slots per pole would be somewhat reduced, which means a greater potential difference between commutator segments and also a greater reactance voltage, which indicates a considerably greater chance of non-sparkless commutation. From the above it will be seen that a low speed high frequency double current generator would be characterised by a large diameter and small width, but with a low frequency and high speed very little difference would exist from an ordinary continuous current machine, and both these latter circumstances, in England at any rate, are exactly what are found. The voltage ratio between the continuous and alternating sides of a double current generator is, of course, fixed as in a rotary converter. In an n-phase machine in which n points are connected to the slip rings (in a multipolar machine this refers to n points per pair of poles), the potential between any slip ring and the neutral point is obviously

$$E = \frac{\varepsilon}{2\sqrt{2}};$$

and, therefore, the potential between any two slip rings is:—

$$E = \frac{\varepsilon \sin \frac{\pi}{n}}{\sqrt{2}}$$

where E = R.M.S. volts, and ε = continuous current volts between brushes. The current per line

$$C = \frac{2\sqrt{2}\,c}{n},$$

and the current from line to line, will be, therefore,

$$C = \frac{\sqrt{2}\cdot c}{n \sin \frac{\pi}{n}},$$

where C = alternating current and c = continuous current.

These values are, of course, on the assumption of a sine wave; while, however, in a rotary converter these values are closely approximated to owing to a distributed winding being used, it does not follow that it will be so in a double current generator, as the pole arc is often considerably reduced and the number of slots per pole is somewhat less. In a high speed low frequency machine, however, the above formulæ will figure out fairly accurately, if armature losses be allowed for. Just as in a rotary converter, however, the direct current voltage has a fixed ratio to the maximum value of the alternating wave and only indirectly to the effective value (the effective value $\frac{1}{\sqrt{2}}$ of the maximum value for a sine wave)—clearly, therefore, a different ratio of effective to maximum values will alter the ratio of direct and alternating potentials, in fact, the ratio is changed in proportion to the ratio of effective to maximum value.

In order to transmit the alternating current, its potential has, of course, to be transformed up by means of raising transformers, and in figuring out the cost of a scheme, the cost of the transformers must be added to that of the generators. It is usual in such machines to regulate the direct current side by means of the field rheostat, the alternating side either being regulated by means of an induction regulator, or in some cases being entirely left alone. The author is decidedly in favour of sub-stations equipped with induction motors coupled to direct current generators when receiving their supply from double current machines, since no regulation is required on the alternating side of the generator. As everyone knows, all induction motors will carry 25 per cent. overload for two hours and 50 per cent. momentarily, and since the output varies as the square of the voltage on the motor terminals, and assuming 10 per cent. drop in voltage

on the line for some cause or another, we should get with, say, 5,000-volt transmission,

$$150 \text{ per cent.} \times \left(\frac{4,500}{5,000}\right)^2 = 120 \text{ per cent. of the rated output,}$$

thus leaving an ample margin for temporary overloads. Furthermore, the induction motor is independent of the fluctuations of the generator speed, and whereas momentary drops in voltage have little or no effect on the induction motor, yet the same drop may cause a synchronous machine to drop out of synchronism entirely, and come to rest. Of course, the torque of a synchronous motor varies directly as the applied voltage, and therefore the synchronous machine will stand its torque longer, but in the induction motor a lowering in speed due either to a heavy overload or a drop in voltage may occur; yet as soon as the overload is removed the motor attains its normal speed again. With a synchronous machine, however, this is not so, and the motor comes to a dead stand. The induction motor set would, of course, require an excessive current for starting, unless a compensator or some other arrangement were used, but provided the set were not large compared with the generator units, no large pressure drop should result, due to heavy starting currents and low power factor. It will be seen, therefore, that no transformers, starting motor, synchronising gear, &c., will be necessary in the sub-station, and the wages of attendants can be cut down to a minimum, since no expert is necessary; besides, there is no fear of hunting, &c., and this appears to be a good off-set for the better power factor and efficiency obtained with a synchronous set. Even taking account of the above, there are many cases where rotary converters are indeed preferable, especially where one generating station supplies only alternating current, and where the pressure can be maintained constant, but in double current stations where the pressure on the direct current side is regulated by the field rheostat, asynchronous machinery appears preferable.

In a rotary converter sub-station it is essential to keep the primary voltage on the transformers constant, as otherwise the direct current voltage would vary, and therefore an induction regulator becomes necessary (this piece of apparatus was described in the ELECTRICAL REVIEW of January 3rd last); it is preferably installed in the sub-station itself, on the high tension side of the system.

THE ELECTRICAL TRADE OF THE UNITED STATES.

IN connection with the ordinary census of the United States for the year 1900, the Census Office at Washington has just issued a bulletin, which deals with the electrical industry of that country from the manufacturing point of view. The report extends to 55 large pages of close type, and includes 31 tables, some of extraordinary complexity, so that although we may strive to note down some of the more salient features of the bulletin, it is impossible, in the space at our disposal, to do justice to the subject, or to the marvellous skill and patience with which the present document has been compiled by Mr. T. C. Martin, of New York.

Allowing for the fact that the figures quoted do not include details of local companies interested in lighting, telephone, street railway, and other work, the following table shows at once the magnitude of the business in the U.S., and the manner in which it has grown during the past two decades:—

Dates of census	1900.	1890.	1880.
Number of establishments	580	189	76
Capital	$83,130,943	$18,997,337	$1,509,758
Number of salaried officials	4,987	683	?
„ wage-earners ...	40,890	8,002	1,271
Cost of materials used ...	$48,916,440	$8,819,498	$1,116,470
Value of products, including custom work and repairing	$91,348,889	$19,114,714	$2,655,036

In drawing up this and the subsidiary tables, the latter of which cover the whole country, State by State, itemising such little things as glow-lamp sockets, data coming from 132 other concerns were studied, an inclusion of which would bring the factories up to 712, and the value of the products to nearly $105,000,000. These, however, have been excluded to avoid overlapping, inasmuch as the latter firms are only partly electrical. Similarly, no account is taken of any description of bare iron or copper wire, nor of steel rails for trolley systems, nor of wood or metal poles, nor of the various products of the electrolytic cell and the electric furnace.

10,527 dynamos were built in 1900, the average capacity being 75 H.P. Of them 9,182 machines yielded direct current averaging 47 H.P. in size, while 1,345 alternators of 254 mean H.P. were constructed. The 5,000-H.P. alternators at Niagara which develop current at 2,200 volts, are now small in comparison with the new 10,000-H.P. machines; and as the latter give a 12,000-volt current at once, step-up transformers are dispensed with. Thus it happens that these last generators have cost only about $7 per H.P., whereas the 10,000 odd dynamos mentioned above cost nearly $14 per H.P. Motors to an aggregate value of $19,505,504 were sold in 1900. Of these 15,284 were used on railways; 3,017 (H.P. 8,220) for motor cars; and 97,577 (H.P. 12,766) for fans alone. This latter employment for electricity is specially valuable to the central station engineer, for as a fan takes about the same current as an ordinary incandescent lamp, and often runs all day long in the summer, while the lamp frequently burns only for an hour or two of a winter's evening, the adoption of these apparatus helps greatly to equalise the summer and winter load.

Storage batteries to the value of $2,559,601 were made in 1900, all of the lead-lead type; it is estimated that $11,000,000 have been invested in these apparatus by central stations, isolated lighting plants, and street railway concerns. In New York the standard type of 44-cell car battery has been improved from a weight of 1,790 lbs., and a travelling radius of 28½ miles, to a weight of 1,650 lbs., and a radius of 42¾ miles. These propel a vehicle with driver and two passengers weighing 5,300 lbs. altogether; 75 of the new type were in regular use during 1900, making average distances of 3,742 miles. Dry primary batteries were reduced in price during 1900 to a cost of about 10 cents per cell, having originally been three or four times as expensive. The total value of carbons reached $1,731,248; $1,263,732 worth being employed for lighting, and $136,679 worth for brush manufacture. Out of 158,187 arc lights produced in 1900, only 23,656 were of the open variety; and whereas 73 cities use direct current enclosed arcs for street lighting, 326 cities employ series alternating enclosed lamps, deriving their current from constant-current transformers. 21 million 16-C.P. glow lamps, 3 million smaller ones, and 1 million larger ones were made in 1900, the total value being $4,000,000. Bulbs are getting smaller in order to economise glass and platinum; but are larger than those of European lamps.

The value of telephones constructed in 1900 was $10,512,412. In 1880 the Bell systems had a combined capital of $15,502,135, and employed 3,338 persons; by 1900 the capital had risen to $300,000,000 and the number of employés to 33,000. These figures do not include the "independent" systems so common in the middle and north-western States, whose capital amounts to another $150,000,000. In 1900 there was one instrument to every 40 persons in the United States generally; while in San Francisco, for instance, the telephones are 1:12 per head. Multiple switchboards are growing till it is said that one girl can deal with 100,000 subscribers at "central." There were 11 establishments making phonographs and graphophones, the value of their products reaching $2,246,274, the number of complete instruments being 151,403. The value of the telegraph instruments reached $1,642,266; but the figures are misleading as so many railroad and similar concerns make their own, and do not supply the public; in fact, $1,231,167 worth of the telegraph apparatus quoted was for police work, fire alarms, and similar special purposes. Insulated wire and cable made in 1900 had a value of $21,292,000, but at the time mentioned no deep-sea cable was being manufactured in the States. 91,147 pieces of warming, cooking and welding apparatus were constructed, having a total value of $1,186,878.

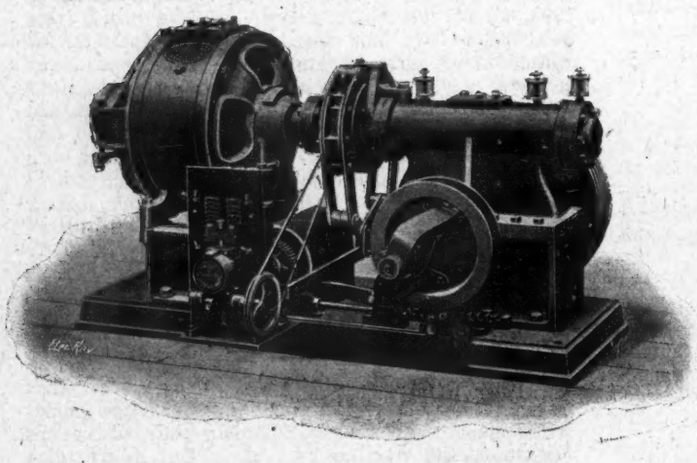
In 1900 there were 877 coal-gas factories in the States, whose capital amounted to $567,000,506, and whose product was worth $75,716,693. The population of the States is nearly 75,000,000. On an average each person spends annually $3 with traction companies, $1·50 on lighting, $1·25 on "electric apparatus and supplies," 75 cents on telephones, and 50 cents on telegraphs, fire alarms, &c. Altogether each citizen spends $7 per year on electricity; so that "at least one explanation of the rapid rise of the U.S. to its present position in international affairs and among the manufacturing nations may be found in this manifest willingness of its people to pay as much for electricity as for bread."

THE WOLVERHAMPTON EXHIBITION.

(*Continued from page* 505.)

Messrs. Holt & Willetts, of Cradley Heath, have an interesting exhibit of electric and other lifts, jacks, pulley blocks, &c. The driving mechanism of the electric lift, which is shown in operation, is illustrated herewith.

The motor, which is of the E.C.C. semi-enclosed multipolar compound-wound type, drives a worm of hardened steel, gearing with a machine-cut phosphor bronze wheel; the latter is enclosed in an oil-tight case, and is keyed to a steel shaft, which carries a cast-iron drum with four grooves turned in its periphery to receive the steel ropes.



Mechanism of Electric Lift. (Holt & Willetts.)

The thrust of the worm is taken by a ball-bearing. A mechanical brake is fitted to the worm shaft, which comes into operation directly the current is interrupted, and an automatic device provides for opening the main switch at the limits of travel of the cage, to prevent over-winding. The speed controller is automatic; the resistance cannot be cut out of circuit unless the lift starts, and the latter cannot be forced to start with an overload. Should the current fail from any cause, the resistance would be at once inserted in the armature circuit.

The reversing switch is specially designed with several simultaneous breaks to prevent sparking, and is enclosed in a fireproof case; it is operated by a hand rope passing through the cage, in conjunction with a device which ensures that the switch shall not be left in an intermediate position.

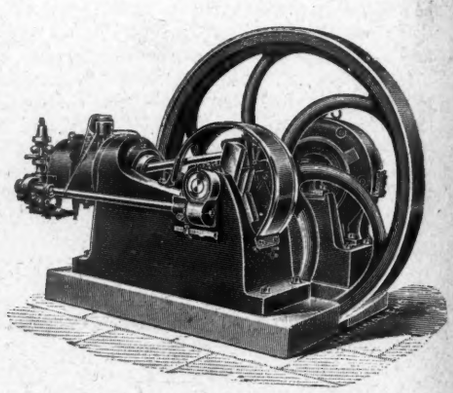
The cage is counter-poised with cast-iron balance weights, and is steadied by pitch-pine guides. An adjustable indicator can be fixed in the cage, which is set by the attendant before starting; the cage will then stop automatically at the stage for which the indicator is set.

The apparatus worked smoothly and with precision, and the simplicity of its construction, combined with the good workmanship with which it was executed, gave reason to anticipate that it would be found reliable in practice and inexpensive in upkeep.

Messrs. Mavor & Coulson's exhibit at their stand consists mainly of an electric bar coal-cutting machine, made according to Hurd's patent. Messrs. Cowlishaw, Walker and Co., Ltd., of Stoke-on-Trent, are their sole licensees for the Midlands and Staffordshire districts. The machine embodies many improvements, the outcome of practical experience, which render it well adapted to meet the severe conditions of working obtaining in coal mines. The rotating cutter-bar is fitted with removable cutter picks, and is driven by gear which is entirely dust proof, and runs in an oil bath. The motor is designed to withstand the roughest treatment, and is enclosed gas-tight. The machine automatically hauls itself along as the cut proceeds, at a readily adjustable speed. Three sizes are made, of 12 to 26 h.p., and capable of cutting from 2 ft. 6 in. to 6 ft. deep. The bar cuts its path into the face, and can be used either over or under, at the right hand or the left, and in either direction of travel.

In the power department Messrs. Mavor & Coulson show the dynamo which they exhibited at Glasgow last year, coupled to a Robey engine. The set is capable of an output of 350 kw. at 550 volts, at 90 revolutions per minute. This set was described and illustrated in our issue of August 9th, 1901. Messrs. Robey & Co. are also exhibiting the two vertical engines, of 100 i.h.p. each, coupled to Scott and Mountain dynamos, which they showed at Glasgow; these were described in the same issue.

The National Gas Engine Co. show seven of their machines, ranging in power from 2 to 85 b.h.p. One of these is coupled to a multipolar dynamo, and is rated at



9-b.h.p. National Gas Engine and Dynamo.

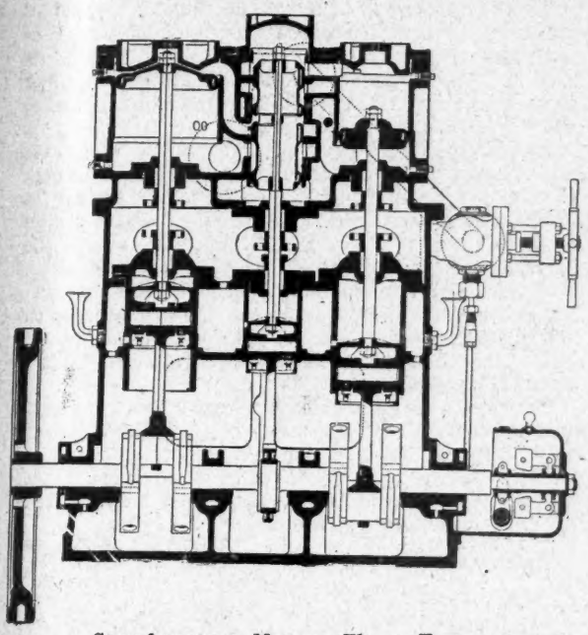
9 b.h.p.; this, as well as the 85 b.h.p. engine, was specially designed for electrical work. The latter is shown in one of our views as it would appear in working. The special features claimed for these engines are good lubrication, steady running and ease of access to the valves for cleaning. The ignition tube is of porcelain, and is supported at both

85-b.h.p. National Gas Engine, Coupled to Dynamo.

ends without coming into contact with the cold metal, so that the tube is uniformly heated and lasts for years. The cylinders are always fitted with loose liners of hard metal

which are easily renewed, and every care is taken to ensure the use of good material and workmanship.

Messrs. The Mirrlees, Watson Co., Ltd., of Glasgow, show two enclosed high-speed single-acting engines; one of these is of 60 I.H.P., running at 550 revolutions per minute, and has cylinders 10 in. and 14 in. in diameter, with a stroke of 7 in. The other engine is rated at 30 I.H.P., and



Cross-Section of Mirrlees-Watson Engine.

runs at the high speed of 700 revolutions per minute; this engine is coupled to a dynamo by Messrs. Mavor & Coulson, and has cylinders 6¾ and 10 in. in diameter, 5 in. stroke. The cross-section herewith shows the arrangement of the valve gear in this type of engine. The valves for both cylinders are worked by a single eccentric; the cranks splash into the oil reservoir in the bedplate, thus automatically lubricating themselves, the bearings and the air buffer pistons. The speed is controlled by a throttle governor mounted on the main shaft.

Messrs. Bumsted & Chandler, of Hednesford, exhibit an induced draught single inlet fan driven direct by a steam engine, both of the well-known Chandler patent type, and suitable for passing hot gases at a temperature of 600° F. from a battery of boilers into a smoke stack. The fan impeller is 54 in. diameter, and is provided with a large number of specially curved vanes, the exact length and curvature of which depend upon the special circumstances of each case and the duty required. This fan underwent a prolonged series of tests at the maker's works, and it passed a volume of air equivalent to 50,000 cubic ft. per minute. The engine is a 20-B.H.P. compound, with single crank, suitable for 160 lbs. steam pressure, and the valves are worked by a lever which derives its motion from the connecting rod. With this arrangement the economy of steam is excellent, the consumption being only 18 lbs. per I.H.P. per hour when exhausting to condenser, saturated steam being used. The diameter of the high-pressure cylinder is 5 in., and that of the low-pressure cylinder is 9½ in.; the stroke is 7 in. The speed during the test was 425 revolutions per minute.

A working model of a colliery ventilating plant is also shown, the fan being driven direct by the engine, and Messrs. Bumsted & Chandler have lately set to work a similar plant—a 16 ft. diameter fan with steel casing and *evasé* outlet, driven direct by one of their engines—at the Littleton Collieries, Huntington, Cannock; this comparatively small plant passes 300,000 cub. ft. of air per minute at 3 in. water gauge.

A small and compact electric lighting set is also shown; the dynamo, by Messrs. Thomas Parker, of Wolverhampton, gives 35 amperes at 105 volts at 600 revolutions per minute, and is driven direct by a double-crank compound Chandler engine having cylinders 2½ and 4 in. in diameter.

Messrs. Bever, Dorling & Co., Limited, exhibit their latest design of combined steam dynamo. The engine is a compound Bever's patent high-speed balanced engine, with cylinders 6 in. high pressure, 10 in. low pressure, and 6-in. stroke, running at 800 revolutions per minute. It is coupled to a four-pole generator, giving 40 KW. at 230 volts, at 800 revolutions per minute, by the Phœnix Dynamo Manufacturing Company, of Bradford.

This type of high-speed self-contained engine has a high pressure cylinder and a low pressure cylinder on each side of the crankshaft, full steam pressure acting constantly on the outer sides of the high pressure pistons, and acting intermittently and expanding on the inner sides of the low pressure pistons. The engines being balanced as regards pressures, revolving and reciprocating weights, they can be run at a very high speed with perfect steadiness and without vibration. All the working parts run in a bath of oil.

The generator has a slotted drum armature with former-wound barrel winding. The armature conductors are of high conductivity copper strip, carefully insulated with pressspahn and mica previous to the winding being assembled. The core is built up of high quality soft-steel stampings, insulated from each other to prevent loss by eddy currents and hysteresis.

The machine is designed with a positive fixed position of brush at all loads, will run for two hours at 25 per cent. overload, and will stand 50 per cent. overload for considerable periods without injurious heating and absolutely sparklessly.

The bearings are of the self-aligning spherical type, the length being three times the diameter of the shaft. Two oil rings are provided, which ensure a copious supply of oil.

On this stand is also a three-throw motor-driven vertical pump, suitable for boiler feeding up to 250 lbs. per sq. in., or for pumping against a head of water up to 600 ft. The pump is driven by a 12-H.P. motor, by means of a Buffoline pinion gearing into a cut cast-iron wheel. The motor is of the semi-enclosed four-pole type for 230 volts, made by the Phœnix Dynamo Manufacturing Company, the output being 10 B.H.P. at 800 revolutions per minute; the temperature rise does not exceed 80° F. above the surrounding atmosphere after 6 hours' run. The armature is of the slotted type, with former-shaped coils and barrel end windings. Hinged doors are provided for access to the brush gear, &c. The end bearing supports are so arranged that the motor may be bolted or fixed to any angle, *i.e.*, to a wall or under roof girders, without affecting the lubrication.

Another exhibit is one of Bever's patent duplex steam pumping engines, with 6-in. cylinders, 4-in. pumps and 10-in. stroke, suitable for general pumping purposes, boiler feeding, fire pumping, &c.

The motor and three-throw pump is driven by the generator in connection with the high-speed engine, which at the same time lights all the lamps on the stand, in addition to the signs.

The automatic slow-starting motor switches used are by Mr. H. Hodgson Wright, of Halifax, who is also the manufacturer of the main switchboard.

(To be continued.)

THE DIFFICULTIES THAT STUDENTS OF ELECTRICAL ENGINEERING MEET WITH.

By A STUDENT.

I am a student, I think as a student, and I write as a student, and I write this little article on behalf of my fellow students, in the hope that in some small way I may give voice to the various difficulties that all students of our profession, with whom I have come into contact, seem to meet with. Of course, all students do not meet with the same difficulties; problems that are insurmountable to some are perfectly simple to others, but still there are some things that nearly all of us experience difficulty with, and if only we stated our difficulties a bit more clearly, and spoke out more loudly, perhaps more trouble would be taken to guide us on the somewhat thorny path we have chosen.

From the mere fact that we are students, however, we are almost debarred from the use of the columns of professional papers; we are considered nobodies, or, at least, only somebodies who are to do what we are told, to learn just what professors and mathematicians feel in the mood to teach us, and to believe that it is good to study this or that just because we are told it is good.

If this little article, however, meet the eye of some learned professor steeped in *dx* and *dy*, or that of some eminent consulting engineer who has forgotten that he ever was a student himself, and they should lift the finger of scorn, I would say to them, Beware! remember that the student of to-day is the engineer of to-morrow: remember that our engineering reputation is being attacked on all sides, and that, especially in matters electrical, other nations are actually worsting us. Remember that the seeds of instruction which you sow to-day will bear fruit to-morrow, and accordingly as you train us to-day, so shall our great engineering industry thrive or fall to-morrow.

The training of electrical engineers has become of vast importance, and the subject has been under discussion, and much has been written by learned writers, but why should not the student have his little say, the more so seeing that he is the person directly interested.

I would preface what I am going to say by the statement that I am only writing for a certain class of student, *i.e.*, the average hard working, industrial student who is trying his very best to get on with the brains at his disposal.

There are two other classes of student, firstly, the exceptionally clever and brilliant student, to whom all things are easy, and come as second nature, and those of us who belong to this class are, alas, all too few; and secondly, there is the well-known, and I am afraid, rather numerous class of ne'er-do-wells, who are students only in name. To these two classes of students it matters very little what system of training they undergo. The one will be a success, and the other a failure, under almost any system.

Now to work. I will try and be as brief as I can.

First, the student of electrical engineering has a somewhat undefined idea that he is being taught much that will never be of any use to him in the future. This does not appear to be the case in most other professions. For example, a medical student knows that when he learns how to perform an operation, or how to treat some special disease, that he is learning the work that he will actually have to perform himself later on. Take now the case of the engineer student. He knows well enough that when he is learning how to draw a sine curve, or (in his practical work) how to clean wires and joint a cable, that in all probability he will never have to do this again in his life.

At the outset of his training, then, the student is apt to be suspicious of what he is taught, and day after day he becomes more inclined to pick and choose for himself what special thing he will study, and what he will entirely leave alone. One student will have a leaning towards the practical part of his work, and tell you that theory is all "rot," and "no good," and only fit for Professor "Dryasdust." Another student will not like to soil his hands, and would scorn the knowledge of how to use a hammer and chisel as being only of use to mere fitters. Another, while revelling in calculus, dislikes chemistry, and refuses to make "stinks." So we could go on, the chances being that the student, in his ignorance and inexperience, is apt to place among those things which he classes as no good, just the very thing that he will most require in after life. His position is deplorable. He says he has not time to learn everything; yet, what is he to learn and what is he to leave? Each professor and master naturally glorifies the one special subject which he teaches, and duly impresses on the unfortunate student that, whatever else he leaves alone, it is to the utmost importance that he learns that particular subject, so that no help is to be had from those whose place it is to give help in this matter.

Coming, now, to the chief difficulty that all students seem to experience, it is this—the want of *combination of theory and practice*. The relation between theory and practice should be most clearly shown; and yet, what is the case in practically every scientific institution that exists in this country? Why just the very opposite; a broad and yawning gulf, a veritable line of demarcation appears to be drawn, and the student feels this gap in his training, and seeks in vain for some bridge by which to cross.

In the class room he learns much of mathematics, of trigonometry and calculus. He has all sorts of weird curves and waves of E.M.F. and current drawn for him on the black board. He learns how to talk intelligently of power factors, of the paralleling of alternators, and so on. In the "shops" he learns how to turn a commutator, to wind an armature, and so on, and generally the work of a fitter or electrician; but, at the end of all this training, he still feels that he is in no sense an electrical engineer—and why? because the work of the engineer is to *apply theory to practice*, and this he has never been taught.

All colleges at which electrical engineering is taught have now extensive laboratories, and the student is taught the work of testing. He is taught, for example, how to find the efficiency of a direct current dynamo, the different sources of loss of energy in it, how to determine the characteristic curve, how to test transformers and arc lamps, and so on. So far so good; testing is most useful and necessary work, but the thinking student and the one who wants to get on would like to go a step further. He does not rest content with testing somebody else's work; he wishes to build a dynamo or a transformer of his own.

Then comes the great difficulty; there is nobody to teach him how to do it. His professors being probably entirely theoretical men, cannot tell him how to wind an armature, while, when he goes through the shops the workmen, though they can tell him how to do this, cannot tell him why there are 48 conductors on it instead of 50.

The subject then of the design of electrical machinery, the work to which the student hopes to devote his life, is never taught. No practical bearing is taught him between the results which he obtained from tests of apparatus in the laboratory, and as to how he is to apply the knowledge gained from these results to the design and improvement of similar apparatus in the future.

The great connecting link between pure theory and the actual manual work of construction is missing, and the student, after finishing a lengthy course of theory and of "shops," would still be at quite a loss as to how to construct a small dynamo or motor to fulfil given conditions.

He has learned sufficient practice to be able to build the machine from drawings and data when supplied, and he has a sufficient theoretical knowledge to test the efficiency and power when he has made it; but if he were given the conditions of running and a piece of paper, and asked to sit down and work out the design and details, he would absolutely be at a loss to know how even to begin. He would have no idea as to how many commutator bars he should have, as to what should be the ratio of length to diameter of armature, as to what magnetic leakage he must allow for, and so on. Surely all systems that neglect to teach these important points are gravely deficient.

(*To be concluded.*)

CORRESPONDENCE.

Sales.

The able article which appears under this head in your issue of September 5th is so full of sound common sense, that all those who are interested in electrical sales should read it through carefully, and seek to apply its recommendations where it is possible to do so. You say:—

"It is not so much in the actual manufacturing, as on the commercial side, that old-established firms in this country will have to adapt themselves to the requirements of the day."

Again you proceed:—"There is no gainsaying the fact that many of the newer firms that have commenced business in this country are paying as much attention to this in the way of an efficient staff for dealing with their sales and their business generally, as they are to the actual manufacture of their specialities."

Then further:—"A commercial organisation is a somewhat difficult thing for an old-established firm to overhaul,

as in most cases it concerns more directly the directors and the principals themselves, &c."

These are plain, indisputable facts, which must be obvious to all who are connected with the commercial departments of any of our large electrical undertakings, and the sooner those who are in authority realise these facts, and seek to remedy the existing state of things, the sooner will they find themselves, and their shareholders, in a position to pocket dividends, rather than lament the keen competition which they find in the English markets to-day.

The need for reform is undoubtedly great, in order that we may compete with the enterprising foreigners, and show them that we can, and do, produce a superior article, and having produced it, are capable of effecting its sale.

What is wanted is an "efficient staff for dealing with the sales." Yes, certainly; by this is not meant one who is a friend of a director—one who has so many shares in a concern, nor one who is a relative of a large shareholder, but a man who has *secured* and *holds* his appointment on *his own* merits. How many such men are there to-day? I fear too few.

The firms who are to succeed in the future must be represented in their sales departments by a man having an experience with the article on the sale of which his firm's dividend depends. A man is wanted who is able to bring the manufacturer and the consumer into closer touch with each other, who can listen sympathetically to the requirements of the consumer and seek to meet his wishes without forcing upon him something he does not care for, while at the same time he will with courtesy and tact seek to bring the client into line with the improved productions of the manufacturer by tendering reliable advice, based upon his own personal experience and knowledge.

I have myself come across cases in which travellers and local representatives alike have not been able to give advice on the most simple matters without consulting the manufacturers whom they represented.

"A commercial organisation is a difficult thing to overhaul." No doubt it is, but are not some of our commercial departments of to-day quite out of proportion to the turnover of the manufacturing departments; and likewise the amount expended on the clerical departments out of proportion to the amount expended on the production of the article to be sold?

Between the producer and the salesman there are too many people engaged making out statements, &c., &c., and thereby adding to the selling price of the article without a corresponding increase in its value.

If the salesman, manufacturer, and consumer can be brought in closer communion with each other, I am convinced that the confidence and trade of the latter will be gained by the former.

It would appear that to-day many of our large firms are endeavouring to carry on both a wholesale and a retail business, and do neither very successfully—if this is so, they may find a remedy if they will advertise freely, and at the same time judiciously, then convert every man in the trade into an advertising medium by offering such terms as shall make it worth their while to become active selling agents; for after all, those who are engaged in the trade are the persons most likely to influence business. The creative department, recommended by Mr. Young in your current issue, would not be necessary if manufacturers would give a judicious consideration to suggestions from salesmen, though emanating from the consumer.

E. M. F.

September 24th, 1902.

In view of the oft-repeated outcry that foreign competition is ruining our home markets for electrical goods, a few comments on the commercial side of electrical manufacturing may, I think, be of interest.

As a fact, this foreign competition is at last beginning to fade away in the back-ground, and in its place we find our home manufacturers, after having increased their powers of production far beyond the increased demand in electrical goods, setting up amongst themselves a competition and fight for business, quite as intense as that which prevailed when our foreign friends, with their large installations, cheap labour and early state of preparedness, were flooding this country with their cheap goods. It requires no prophet to point out that the old style of competition, with its heavy margin of profit, cannot continue indefinitely. Even now prices are falling in a most erratic manner. The writer, after comparing prices quoted on many contracts during the last 12 months, is convinced that in many cases the tenders accepted will not bear sufficient profit for the successful contractors to enable them to stand by the users of their appliances in the manner which sound commercial instinct teaches is the keynote to a successful name.

As a result of this keen internal competition, it is certain that only those firms having first-class outside staffs, in addition to most skilful engineers at home, will be able to survive the inevitable struggle, for in the future, success will depend equally as much upon the commercial element as upon the manufacturing ability, from the fact that modern shops of repute all possess the highest and latest developments in mechanical appliances for economical production, and, therefore, amongst the best of them the difference in shop cost is so little, that competition will surely resolve itself into one of keen rivalry between the salesmen as to who shall display the greatest selling ability and tact, and so take the bulk of the business.

These competing firms will all, of necessity, be forced into establishing highly trained commercial organisations, always in touch with the changing requirements of the public. Concerns manufacturing electrical appliances, by reason of the peculiar highly scientific developments in their trade which we see taking place day by day, must be in a position to advise their clients as to the best and most suitable methods to adopt for particular needs, and to those firms who place their selling staff in a position to give the soundest advice with the minimum of trouble to the purchaser will the preponderant weight of business accrue.

One reason why foreign competitors have sold in the past, and, indeed, still sell their manufactures better than we do, is that their selling organisation shows greater ability, enterprise and energy. They can certainly teach us more in this branch of the engineering business than in any other, and they deem the selling part of their business of the greatest importance, and cultivate it in many instances more carefully than the manufacturing side. It is in this fact that their success has hitherto mainly lain, and the only way to compete successfully with their manufactures is to imitate them in this particular, and to establish well-trained staffs of engineering salesmen, trained in the shops, in the schools and in the departments, with a good organiser at their head, keenly alive to the requirements of his customers and to the interests of his company.

T. W. Sheffield, A.M.I.E.E.

September 25th, 1902.

A Question of Trade Etiquette.

The letter of your correspondent, "Puzzled," touches a matter which needs ventilation in the interests of honest trading.

We have had several claims for commission under somewhat similar circumstances, where the orders for electric fans were obtained through architects or consulting engineers in keen competition, quite independent of the contractors.

We have also recently had a claim for commission on a motor for driving machinery from a firm of contractors who are doing the wiring, of whose existence we were unaware until we received their letter, as follows:—

Dear Sirs,—As the order has now been placed with you for a motor for ——— of ——— here, and as we are doing the wiring of this building, and would have got the order for the motor had you refused to supply direct, we will be glad to have your remittance for the usual commission (viz., 10 per cent.).

This order was received in competition through a consulting engineer, and we quite fail to see the justice of the contractors' claim for commission. There is, however, another point to consider, viz., as the wiring, and probably the connecting, starting, and subsequent care of the motors may be in the hands of the contractors, it becomes a question as to how far the non-payment of the commission claimed may prejudice the satisfactory working of the motors. It is a very easy thing to queer a motor and lay the blame on the

maker, causing him considerable trouble and loss, and it is not impossible that firms capable of making the claims stated would take the action indicated. We look upon such claims as little less than blackmail, and think that quick and decisive action to prevent them should be taken by somebody having the requisite authority.

We prefer to supply through the trade, but are in the hands of the buyers.

Annoyed.

Electric Hoists.

I have only just seen "J. G. Y. D. M.'s" letter, and am, consequently, too late for your next issue, but perhaps it may be still worth while to make a suggestion.

It appears that the trouble experienced is entirely due to the want of a margin within which the motor may be stopped. Why cannot this be provided by the introduction of a spring connection in the gear?

For instance, the winding drum or the worm might be connected to its shaft by a helical spring after the manner of the roller of a spring blind.

This would allow the motor to make a number of revolutions after the table had come in contact with its stops, would act as a brake to the motor, and would assist in starting the reverse movement.

If the spring were on the drum shaft, probably the magnetic brake could be dispensed with, the worm gear sufficing to hold the spring compressed.

W. S. Boult.

Wandsworth, S.W.
September 24th, 1902.

Mechanical Engineers for Electric Generating Stations.

Owing to pressure of business, I have been unable to reply to your correspondents, "The Shift Engineer," and "A Member of a Purely Electrical Staff."

If you will kindly grant me the space, I will do so now.

"The Shift Engineer" takes exception to my statement that the fitter or station superintendent runs the station.

Who really runs, &c., of course means—who maintains the plant in thorough working order?

The work of starting-up, &c., the steam sets, is performed by the engine drivers (the shift engineer, by the way, is not allowed to handle the engines); the time to do so is governed by the load on the station, &c. Then your correspondent thinks that I have very imperfect ideas of a shift engineer's life and the detail of an ordinary electricity works.

May I inform him that I have had over 15 years' practical, mechanical, and electrical engineering experience, and have held the post of station superintendent in a station of several thousands KW. capacity, so comment is needless.

I assure him that it is quite true that many assistants cannot take indicator diagrams, or make steam consumption tests, but I do not see how the fact reflects on the chief. Does your correspondent mean that the chief ought to teach the assistants these things? I maintain that they ought to know their work before being appointed as shift engineers. This bears out my remarks in a previous letter that the majority of the so-called shift engineers are totally incompetent, they are neither mechanical nor electrical engineers, but merely shift station attendants—unskilled labourers!

I do not propose to take your correspondent's advice to take a post similar to the one he occupies, commanding 25s. per week, but if I had equal abilities to his own, I should think I was not badly paid for my work.

"A Member of a Purely Electrical Staff" says that by my own showing mechanical engineers who are chiefs of electricity works, surround themselves with purely electrical assistants. I said nothing of the kind. I pointed out that the chiefs were surrounded by incompetent labourers, the reason being that they could not offer sufficient salaries to induce either mechanical or electrical engineers to take the posts. (I'm quite aware that in some stations the shift engineers are really engineers—not in name only.)

Chief engineers, as a rule, do not look upon electricity as the "great unknown," if "A Member of a Purely Electrical Staff" does. They perfectly understand its generation and distribution, so they have no need to be in terror of it, as your correspondent erroneously concludes.

Your correspondent's remarks about the shift engineers supplying the brain, and the fitter or station superintendent doing the actual work, merely support my statement that the so-called shift engineer is utterly useless, because a competent fitter or station superintendent has brains enough of his own, so does not need the advice of any one else. Moreover, he generally looks with ill-concealed disgust on such brainy individuals as your correspondent represents, who move about the engine room with their hands in their pockets because they are incapable of performing real work. I must still maintain that not 1 in 20 of the so-called shift engineers is able to indicate engines or make consumption tests—the ordinary duties of an engineer in charge of steam plant—because I have proved it by long experience, and it is common knowledge to chief engineers who have dealings with this class of labour. The remainder of your correspondent's letter is only impertinent, so I pass it over without comment.

In conclusion, I may say I see no reason to alter my opinion, and it is the opinion of every competent station engineer, that the majority of so-called shift engineers (men who are neither mechanical nor electrical engineers) are quite incompetent and useless.

Albert E. Vezey, A.M.I.M.E.

London, S.E., *September 30th*, 1902.

THE OLD AND THE NEW ELECTRICAL THEORY.

By ALEX. P. TROTTER.

(*Continued from page* 408.)

But the simple jelly theory, even if the penetrability presents no difficulties, will not fit all the conditions, and it is probable that if ether be rigid, its rigidity is not of so simple a kind. It has been suggested that its rigidity is derived from fast motion, as the quasi-rigidity of a top or hoop; or of a chain, which when hung from a rapidly revolving pulley will remain bent, like a rod of lead, when it is struck, and if lifted off on a sheet of glass, will for a very short time remain stiffly standing up on end, until its motion is stopped by the friction.*

"The elastic solid theory," writes Glazebrook, "taken strictly, fails to represent all the facts of experiment; we have learned an immense amount by its developments, and have been taught where to look for modifications and improvements."†

Many different hypotheses have been put forward to describe (not to explain) the structure of the ether, but it has been found that each has failed to describe all the facts. The first dynamical hypothesis was that of the vortex ether of Lord Kelvin; that gave place to a turbulent ether or vortex-sponge theory, the rigidity in both cases being of the same kind as that of a spinning top. The difficulties that present themselves are not only such facts as the anomalous dispersion of light, which can be investigated and subjected to exact measurement, but conditions such as the connection between ether and gross matter, by which vibrations set up in the latter are imparted to the former.

Helmholtz wrote:—"The change which takes place in a medium which transmits vibrations (whether electromagnetic or light vibrations) is a change in the electric and magnetic polarisation of the medium. In order to explain the propagation of light in space which is free from all trace of ponderable material, one must assume a medium in the electromagnetic theory of light. This medium extends throughout space. In so far, this is the same assumption as is made in the undulatory theory of light; but while in the latter theory one must ascribe to the ether the properties of a solid elastic body (*i.e.*, we make in this theory an assumption regarding the internal structure of the ether), it is not necessary to make any such assumption regarding the ether

* Sir W. Thomson, "Popular Lectures and Addresses," Vol. i., p. 151.

† Glazebrook, "Report on Optical Theories," British Association, 1885.

of the electromagnetic theory. It is only necessary that this ether be capable of being magnetised and electrified (as a dielectric is electrified—*i.e.*, in Faraday's words, it must be "capable of being polarised." *)

The word polarisation, as blessed as "Mesopotamia," has been employed by some writers to disguise their ignorance, and has been worked to death in a dozen totally different branches of science. Helmholtz and Faraday use it, however, in the widest and most general sense.

Ether Displacement.

"Some might say that the distinguishing feature of Maxwell's theory is his dielectric displacement. But it is scarcely that, strictly. For that a dielectric medium was put into a state of polarisation by electric force was Faraday's idea, and this polarisation is only another name for electric displacement. Whether we call it displacement or polarisation does not matter; the important step made by Maxwell was the recognition that changes in the displacement constitute a real electric current (though without dissipation of energy in Joule-heating) . . . . accumulations are done away with altogether, and with their abolition the fluid or fluids become meaningless. As regards the term displacement, though it may be objected to as misleading, suggesting a real displacement in a certain direction, whereas the phenomenon, though undoubtedly having some directional peculiarity, is probably not of the nature of a simple displacement . . . . ." † That this is so probably arises from the fact that the rigidity of the medium is not simple rigidity. It will not do to attribute displacements, or the propagation of displacement, to the stress and elasticity of the medium—this is merely giving the facts names.

"The property of exerting stress when strained is called elasticity . . . . . the nature between configuration and force remains as mysterious as ever. We can only admit the fact, and if we call all such phenomena, phenomena of elasticity, we may find it very convenient to classify them in this way, provided that we remember that by the use of the word elasticity we do not profess to explain the cause of the connection between configuration and energy." ‡ The same may be said for the word "polarisation."

To give a fact a name, and then to think that a step has been taken in the intelligent description or the understanding of that fact is a very common mistake, and one which has done much to impede science. This evil is being recognised to-day, and no better example of the deliberate avoidance of this mistake can be given than in the name "X ray," modestly given by the discoverer to that which is now very properly called Röntgen rays. Electrical resistance, catalysis, and vitalism are names which pretend to give information.

Maxwell propounded, with important reservations, a mechanical hypothesis to account for electrical and magnetic phenomena. "I think," he wrote, § "we have good evidence for the opinion that some phenomenon of rotation is going on in the magnetic field; that this rotation is performed by a great number of very small portions of matter, each rotating on its own axis, this axis being parallel to the direction of the magnetic force, and that the rotations of these different vortices are made to depend on one another by means of some kind of mechanism connecting them. The attempt which I have made to imagine a working model of this mechanism must be taken for no more than it really is, a demonstration that mechanism may be imagined capable of producing a connection mechanically equivalent to the actual connection of the parts of the electro-magnetic field."

To account for the transmission of rotation in the same direction from one molecular vortex to the next, Maxwell imagined between them a number of spherical bodies which roll like idle wheels in machinery, driving without slipping. The following are some of the results of this hypothesis:—(1) Magnetic force is the effect of the centrifugal force of the vortices. (2) Electro-magnetic induction of currents is the effect of the forces called into play when the velocity of the vortices is changing. (3) Electromotive force arises from the stress on the connecting mechanism. (4) Electric displacement arises from the elastic yielding of the connecting mechanism."

This hypothesis of rolling wheels and spheres which, Maxwell was careful to point out, must be taken for no more than it really is, has been elaborated by Prof. Oliver Lodge (one of the few leading electricians who seem to cling to the "thinginess" of electricity) in his "Modern Views of Electricity."

The displacement theory is not advanced sufficiently to enable it to be expressed in language which Faraday would have understood, but that need not deter us from weeding out bits of the old and abandoned theory which block our path, and cultivating bits of the new theory which are likely to develop and bear fruit, and should our work be more destructive than constructive, we, at least, substitute clear ground on which something may be done, for a jungle which impedes all progress.

What is Electricity?

Signals from the deck to the engine room of a steamer are sometimes sent by merely twisting one end of a rod, and causing pointer to turn in front of a dial and a hammer at the other end to hit a bell. There is no longitudinal motion of the rod; that which travels along it is a twist. But we gain nothing by saying that the bell was rung by "twisticity," or by asking whether "twisticity" is a fluid or a force. Again, by using a mechanism like a centrifugal governor as a receiving instrument, we could apply a continuous twist, causing the wire to revolve at different speeds; or, again, we could send signals by using a mechanism like an inertia governor, signals being given by altering the rate of change of twist. The relative position of the parts of such a governor would be the same at different speeds, but they would temporarily alter in position *while the speed was changing*. We cannot conceive this change to go on indefinitely, but a rapidly reversed twist can do so, and this would cause a succession of signals.

There is a superficial analogy here with electrical transmission. Magnetism appears to be associated with, or to be the evidence of, a steady twisting strain in the ether. Electric current (whatever that may really be) is in one sense generated by, or in a more intelligible sense, the evidence of a change of magnetism, and the magnitude or strength of the current is a measure of the rate of change of the magnetism. Currents generated in such a manner are necessarily transient, but we can study their effects if a succession of alternate currents be set up.

Alternations following each other 5 or 10 times per second are used for magneto bells for telephones; from 25 to 120 per second for ordinary electric lighting and transmission of power; from 50 to 40,000 per second for telephones. Then comes a long gap, and from 500 million to 100,000 million per second the alternating disturbances which accompany or are set up by alternating currents will affect Hertz receivers, and may be used for wireless telegraphy; then another gap, and from 170 million million to 395 million million we have currents which can be perceived as radiant heat, and from 395 million million to 770 million million we have visible light, and beyond this, up to 2,000 million million is actinic or chemical radiation, and, possibly far beyond this, Röntgen rays. There is no reason why these gaps should not be filled in. The production of the alternate currents presents but little difficulty, but we have no organs in our bodies or instruments in our laboratories that will perceive or respond to them. It is not inconceivable that the higher vibrations may directly affect the brain, and it may be fancifully suggested that the emotions which are produced by colours and music are the result of high overtones.

(To be continued.)

Manchester.—Under the heading of an "Electric Auditor's Notes," Mr. S. Norbury Williams deals at large and rather severely with many matters. He says "Troublous days lie before the Electricity Committee. The best men in the city are wondering what is going to happen within the next few years. Its expenditure is becoming appalling. What will its income be? We have been rejoicing at the early prospect of £150,000 yearly profit from our tramways. Will a slice of this have to be cut off in order to make up electricity deficits? Time will show."

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* Helmholtz, "Electromagnetic Theory of Light," p. 24.
† Heaviside, I., 477.
‡ Clerk Maxwell, "Matter and Motion," p. 70.
§ Clerk Maxwell, "Electricity and Magnetism," Vol. ii., p. 831.

FEED WATERS AND THEIR ACTION ON BOILERS.

By CLIFFORD A. BOWEN.

It is passing strange, the amount of ignorance displayed by the average engineer with regard to the proper treatment of his boiler plant; everything that can be seen and heard going wrong is rigidly looked after, but the unseen is never thought about, and even when the effects of the unseen become apparent, as in the case of scale pitting and boilers laid by for cleaning, still a glorious passiveness with regard to the proper treatment of the feed is shown, resulting each year in a heavy bill debited against the boiler plant, which might have been very much reduced if only the engineer had shown some slight knowledge, leaving aside for a moment the economy derived from the use of fairly pure water. Look at the evils of scale, the risk of life to the boiler attendants, owing to the over-heating of the plates. When one comes to reckon up the hundreds of deaths due to neglect of boilers, the misery and want thrown down upon the shoulders of the innocent, through the breadwinner of the family being killed by defective boiler plants, defects caused through gross ignorance on the part of those whose duty it is to understand the proper management of boilers, one feels that it is time something was done to make them feel their responsibility. Water is never found absolutely pure; it always contains impurities in a greater or lesser degree, depending from what district it is taken, and from what body of water. The water taken from a river or lake is very much better for feeding a boiler than the water taken from a deep well, because the former is mostly surface water, which has not sunk deep enough to have absorbed very many impurities, though it may have more suspended matter; this is easily got rid of by filtering or by allowing it to settle, while, on the other hand, the water taken from wells contains a lot of impurities injurious to the boiler, which can only be taken away by very careful treatment.

Water may contain very many impurities. The following are the principal which will be dealt with, and which are split into bases and acids:—Bases: soda, ammonia, lime, magnesia, iron; Acids: sulphuric, carbonic, nitric acids; and organic matter.

Rain passing through the atmosphere absorbs a large amount of carbonic acid gas. Carbonic acid has a most pernicious influence when present in water, from an engineer's point of view, dissolving and absorbing impurities which would otherwise be only slightly soluble in water. For instance, lime: the more carbonic acid there is in water the greater the amount of lime there is absorbed, especially in districts where the strata are of chalk or limestone; the greater the depth from which the water comes, the more carbonic acid it contains; consequently, the greater the amount of lime in solution. Therefore, when heat is applied to the water carbonic acid gas is driven off; the lime becoming insoluble falls down as a precipitate. This takes place in the boiler as soon as the feed (cold) enters; some of the precipitate is carried about with the circulation in the boiler, and is deposited in corners; the rest adheres to the hot plates, forming a soft, chalky scale. Should there happen to be any oil or foreign matter of a greasy nature in the boiler, the plates become coated with a greasy film, upon which the precipitate sticks and becomes baked into a hard scale, and all the blowing down in the world will not dislodge it. In consequence, serious overheating of the plates occurs where the deposits are greatest. One would have thought that in water-tube boilers, where the circulation is so very rapid, there could hardly be any scale deposited, but this is far from being the case owing to the rapid evaporation; the deposit of lime comes into contact with the hot tubes, more so than with a Lancashire boiler, and soon coats the tubes with a layer of scale; especially is this the case when oil or greasy matter is present. When scale forms and becomes very thick, besides the loss due to the insulating properties of the scale, the tubes are seriously overheated and acquire a very much higher temperature than the water; the scale not being able to expand and contract at the same rate as the tube, gets loose, and gradually falls away from the heated tube. Water rushing upon the heated tube or plate generates a rush of steam, when, besides a sudden rise in pressure, there may happen one or two other things. The tube being weakened in consequence of overheating, cannot stand the strain of this sudden rise in pressure, and it collapses, or the crown buckles in. If the boiler happens to be strong enough to stand the strain, serious priming takes place; the sudden rush of steam carries water over with it, and the probability is that the cylinder covers may come off the engine. Scale, say, $\frac{1}{32}$ in. thick in a boiler fed with water having organic matter, is decidedly beneficial, but a greater thickness should not be allowed. In all water containing organic matter there are to be found free acids which attack the tubes and plates, causing excessive pitting and corrosion; so that if a slight scale is formed either naturally or by washing with a thin mixture of cement, it protects the iron from the action of the acids; but where the water is drawn from wells where the strata are chalk, all scale should be removed as often as possible. The loss due to scale in boilers is enormous, and too much care cannot be taken to ensure pure water for boiler feeding purposes; for instance, the resistance of scale does not increase in the same ratio as the thickness; it increases faster, as $\frac{1}{16}$ in. causes a loss of 12—15 per cent., while $\frac{1}{8}$ in. causes a loss of from 35 to 40 per cent. As I have said before, the calcium carbonate contained in water is almost directly proportional to the amount of carbonic acid. That being the case, the only economical way of effecting the removal of calcium carbonate is to have settling tanks of some kind, and where the water only contains carbonate of lime, add lime; the amount of lime necessary is about 1 oz. for every degree of hardness per 1,000 gallons, so that if the water is, say, 16° hard, then for every 1,000 gallons passed into the settling tank add 1 lb. of lime, and stir. The above may be slightly in excess of the amount determined by the chemical equation, but, in practice, it is advisable to deal in round numbers; also you are sure that the water is thoroughly treated. It is, however, advisable not to have too great an excess of lime. If there is any objection to the rough method of adding lime, there is another way, and that is, to add lime-water—which really comes to the same thing as adding lime. To water in a barrel or other receptacle add lime, shake, and allow the water to dissolve as much lime as possible; allow to stand and settle, and decant the clear liquor, then add 8 gallons of it per 100 gallons per degree of hardness. In both of the above cases the lime combines with the carbonic acid and precipitates as $Ca\ CO_3$, also liberating the carbonate which was soluble in the presence of the carbonic acid. If the lime-water plan be adopted, the lime-water should be used as it is made, as it will not keep up to full strength. The test for lime-water is as follows: it must impart a strongly marked brown tint to turmeric paper, and give a not too inconsiderable precipitate with carbonate of soda.

Sulphate of lime is a combination of sulphuric acid and lime ($Ca\ SO_4$); the quantity of sulphate of lime held by water is very much less than carbonate of lime owing to the fact that carbonic acid has no effect upon its solubility, and a very good thing it is that such is the case, for sulphate of lime in a boiler is most objectionable on account of the hardness of its deposit, which is most difficult to remove, adhering to the plates with a scale resembling stone. Sulphate of lime, like ordinary salt, is different from most other soluble bodies, insomuch as it is more soluble in a lower temperature than in a higher. Marignac found that at

32° F.	1 gall.	could contain	133 grains.
104°	„	„	149 „
212°	„	„	121 „

Tilden and Shenstone carried their experiments further, and found that at

284° F.	1 gall.	could contain	54 grains.
473°	„	„	12·6 „

so that the idea that most people have that sulphate of lime can be precipitated simply by heating is quite wrong; it can be done in the case of carbonate of lime, for the carbonic acid is driven off, and the carbonate or bicarbonate of lime falls to the bottom of the vessel in which it is heated.

Sulphate of lime not being affected by carbonic acid being driven off, and being soluble in hot water, and as water contains only a small quantity, from 1 grain to 10 or 12 grains per gallon (it is very rare that one sees 10 grains in natural water, generally it is from 3 to 6 grains per gallon), it follows that it can only be precipitated in two ways. One of these is universal in places where the plant is neglected, viz., by evaporating till the water reaches saturation point and deposits all its sulphate on the plates and tubes, cementing the carbonate of lime which is there into a hard stony scale, which is not affected by the blow down, should the man in charge by accident remember that boilers should be blown down. The other method is the addition of soda ash or bicarbonate of soda, tri-sodium, sodium fluoride, caustic soda, tannate of soda; these are all used with success against sulphate of lime, and also any acids that may be present from the unstable salts of the chlorides, nitrates and sulphates; also sugar stuffs and oak bark and leaves are used. The above alkalies all tend to attack the sulphate of lime, and turn it into carbonate of lime and sulphate of soda, or tannates and fluorides of lime and sulphate of soda; the principle underlying all these agents is the same, viz., to convert the hard scale-forming sulphate of lime into a light flocculent precipitate (carbonate of lime) which can be blown out through the blow down; the sulphate of soda remains in solution, and does not deposit till the water in the boiler has become highly concentrated, which it can only do by neglecting the blow down. If the solution in the boiler becomes concentrated, the brass fittings in the boiler are very liable to be attacked. Take a 5 per cent. solution of soda in water and add 3 lbs. of it to every 100 gallons used. The addition of the soda water is got correctly by trial in the following manner: Add to the settling tank the above amount of soda water; then after stirring and allowing to settle, take a test tube and fill it with the treated water, add a drop or two of pheriolphthalein in alcohol You have not enough soda water in the water unless it turns a faint pink—the fainter the colour the better; should you have a pronounced pink turning as far as red, you have an excess of soda, and should in future reduce the amount.

The addition of soda solutions not only renders the sulphate of lime less harmful, but also the sulphates and chlorides of magnesia, acting upon them in the same way. Chlorides, and, for the matter of that, sulphates of magnesia are decomposed upon the application of heat, giving off hydrochloric and sulphuric acids, which, in the presence of the sodium salts, immediately combine, and are rendered harmless. Should there be no soda present, then the acids promptly attack the plates.

(To be concluded.)

THE EXPERIENCES OF A TELEGRAPH ENGINEER IN PERAK STATE, 1898–1901.

By D. P. REID.

On my arrival in Perak I was sent up to the town of Ipoh, in Kinta Valley, and not having any furniture with which to fill my unfurnished bungalow, I was compelled to sleep on the top of the large wooden case containing a bass violin, which some humorously-inclined person had advised me to take to this most unmusical country.

I did not sleep on this my first night in Perak; the bed was hard, and the heat trying, whilst other disturbing influences soon made themselves evident.

By the lamp light I saw dozens of lizards running about the walls and ceilings catching flies, moths, and other small insects, and the whole place seemed infested with insect life, chirping and screeching, until I shuddered again.

Then bats made their appearance, flying through and through the rooms, which are only separated by partitions about 9 ft. high, whilst all the fanlights above doors and windows are open, no glass being used. The houses are made of wood.

Rats, too, came in their numbers, and there was no means of stopping their revels, which were accompanied by uncanny noises in the roof loft.

At this juncture I began to feel as if there "was no place like home;" but when morning came, with its mechanical rising of the sun at 6 a.m., all was changed, and my serenity once more restored, though my back and bones ached painfully, as might well have been expected from the nature of my bed.

In time I was able to get a few articles of furniture together, and a good bed, but I am sure I did not sleep properly for the first six weeks of my residence.

At meal times the ants are very troublesome, and in order to keep them off your table, it is necessary to stand the table legs in basins of water; but, in spite of this precaution, the ants, which are ingenious engineers, are able to construct a sort of bridge from the edge of the basin to the table leg, and once communication is established, they appear in hundreds on the table cloth.

These insects I learned to admire, for besides being quite harmless and clean, they are the scavengers of the floor, and carry away dead flies and any small pieces of food, &c., which may drop from the table.

To a fresh arrival in the East the bullock causes much irritation; that beast is a thorough Easterner and takes his time, in tortoise fashion, as he bears his burden, and a man fresh from the home of vigour feels inclined to push here and kick there, but all is of no avail. The East is as it always has been, and possibly always will be, a slow and sleepy side of the globe; there is an early grave awaiting the man who "tries to hustle the East," and I am at one with Rudyard Kipling in his epigram referring to that doleful side of the question.

At home the saying is, "Never leave till to-morrow what you can do to-day," but the motto of the East is, "Hodie non cras," and oftentimes one has to be content with doing just what he can, for he cannot always do what he will. Many times have I tried to push work on, without avail; the excessive heat, and irritation at not being able to carry out what is wanted in a given time, remind you that you are not at home.

Perak and the neighbouring States, comprising the Straits Settlements, are famous for their tin mines; these alone supply about two-thirds of the world's tin, and are chiefly worked by Chinamen.

The climate is damp, and the heat trying, varying from 75° F. on very cold mornings, to 95° F. in the shade, whilst the sun sends the thermometer to about 130° F.; one had therefore to be well protected by wearing a thick pith topi (hat) shaped like a fisherman's sou'wester and about 1 in. thick, and a thick Chinese pyong (umbrella).

Owing to the great glare thrown from the roads, some of which are made of marble, it is well to protect one's eyes with blue goggles.

The usual comforts of home life are lacking, and the butter, which is bought in tins, is nearly always in a liquid state, and has to be served with a spoon, whilst fowls and other meat foods required for meals must be cooked within an hour or so of their being killed; fresh meat will not keep.

A striking instance of the sad side of life in the tropics is that you might see and talk to a friend first thing in the morning, apparently in good health, and in the afternoon meet his funeral procession. The heat spares nothing, and sanitary conditions demand an early burial of the dead.

Turning now to more technical matters, the railway telegraphs are necessarily of the simplest kind, owing to climatic and other destructive influences; the instruments used are the single current Morse relay sets, worked with Leclanché batteries.

The latter require much attention, owing to rapid evaporation of the liquid. Dry batteries have been tried, without success, and many went bad before even being issued from the stores.

The apparatus gets woven over with spiders' webs at night, and relays seem to be the favourite resort of large cockroaches, which enter when young and small, and live on the paraffined silk of coil-ends, shortly developing into real terrors, and interfering with the working of the relays.

Insect life in the tropics is very vigorous, and the cockroaches fly about like moths around the lamps, sometimes alighting on your neck and face, and otherwise making themselves unpleasant.

The railway is a metre-gauge one, with a single track, having crossing loops at stations, and the more one becomes acquainted with the country and native labour, the more creditable does the work seem. There are now about 126 miles open for traffic, and other sections are in course of construction.

Klings from India are employed as coolies, while Tamils make clerks and overseers. The Chinese, however, are more skilful, and serve well as blacksmiths, carpenters, &c., and Cingalese do the work of fitters, &c., in the locomotive shops.

In the telegraph department the operators are Tamils, and the linesmen and coolies Klings. The former sometimes make fair operators, but, from what I have seen of them, the good telegraphist is more often the exception than the rule.

Klings in the capacity of labourers are really the only class available for that kind of work, and serve very well for a not impatient master.

During the time it was my lot to have control of this class of native, there was no occasion to use a stick, and I have reason to believe that the work progressed satisfactorily, though my patience was often tried.

It is difficult to make the native depart from his own method of working, and the time I first witnessed the men repair a broken line it afforded me no little amusement as well as interest.

The tindal (head man), an intelligent Kanaasese, took a piece of rope 10 ft. long, bound up at the ends to prevent fraying. This rope was moistened at the ends in the swamp by the railway side, the bindings at the two poles either side of the break were opened, and the line let down to the ground.

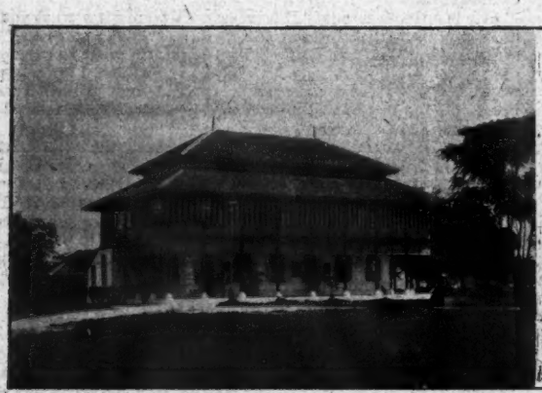
The tindal then opened the strands of the rope at the ends, by twisting it backwards, and fastened it at each end to one of the broken wire ends, and then by forming a loop in the middle of the rope and inserting a piece of jungle stick, which is turned round in such a way as to make the rope twist round itself, the broken ends

of the line are pulled together till they overlap sufficiently to enable a joint to be made (see figure below).

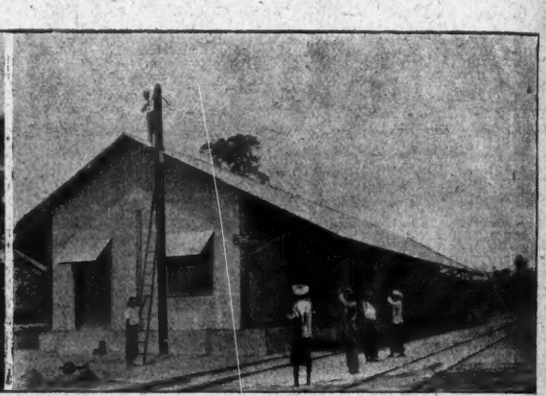
It is astonishing how handy the men are; they seem to be able to produce a substitute for everything out of nothing, and in the soldering of joints a coolie can make a fire of a few dry jungle sticks and have the solder heated in no time, while another man will produce a cup of water to wash the joint with, the cup being made out of some jungle hay plucked hard by.

The line is then bound up to the insulators in the usual way by a coolie, who will run up the pole with his hands and feet, carrying the line bound to his headcloth, which is gripped in his teeth or tied round his neck.

In the matter of pole-erecting the Klings are no less interesting. At hole-digging they are very clever, and with a holing-spade can make a clean hole almost exactly the size of the pole in dry ground; when the hole is too deep to allow them to bring up more earth on the spade, they improvise a kind of scoop made of half a cocoanut shell, and run the end of about 6 ft. of wire into it, and fix the shell ladle-fashion, using this most effectively for cleaning purposes.



Postal Telegraph Office at Ipoh.



Erecting a Telegraph Line.

Native Linemen Making a Joint.

Group of Malays.

In raising the poles the Klings sometimes show great lack of confidence in each other, and each man seems afraid that the other is going to let go the pole when it is half raised. At this particular juncture the men must be severely watched, for on several occasions I have seen men get their legs and hips broken through a sort of panic seizing the gang and ending in all letting go; and the pole coming down on the least fortunate man, generally crippled him.

Tourniquet for Jointing.

When the pole is up, a man runs up and fixes the bolts and insulators, &c.

On a line which has been up some time, one finds that ants and wasps begin to build their nests round about and inside the insulators. These nests sometimes have the appearance of sponges jammed all round the insulators, and when many of them are in existence, the insulation is much impaired.

The line coolies—who should walk their sections every day—do not care to go up and interfere with these nests for fear of being severely stung by the wasps, or bitten by the ants, and it is sometimes necessary to burn the insects out by burning something on the end of a long bamboo stick and holding it under the nests; in the case of wasps this is not a pleasant task.

Perak is swampy in places, and my heart has often gone out to the poor coolies, who sometimes have to go up to their necks in water to effect repairs, &c.

These swamps are generally full of large leeches, and I have often seen a coolie go into the water for five minutes, and come out covered with long leeches, whilst a man on the bank quickly runs to his assistance and pulls them off his back, arms and legs.

It is always, I think, better to make a leech relinquish his hold of his own accord, for, if pulled off by hand, he may leave part of his nose in your leg, with the result that a large and troublesome sore may develop and last for two or three weeks.

The most usual thing to do is to take the shank of your pipe off and apply any nicotine there may be, to the head of the leech, which generally lets go and drops off. In case of not having a pipe, it is not a bad idea to strike a match and apply the warm end; this is sometimes a very good remedy.

In the early morning, birds, chiefly swallows, perch on the telegraph wires in great numbers, and sometimes completely occupy spans from pole to pole side by side. This is especially noticeable near rivers, as in one locality, where the Post Office lines cross the Perak River, near Kuala Kangsa, and another at Batu Gajah, where the railway wires cross the water.

There is no doubt that in the case of copper lines these birds have been the cause of much sagging. Owing to frequent contacts between the railway and Post Office lines, which ran some distance on the same poles, it was at the outset my wish to rectify matters. The telegraphs were in a very poor condition (in many cases there being only 15 poles to the mile, and in others never more than 18), and it was absolutely necessary to increase the number to 24 to the mile without delay; even this number was sometimes insufficient, owing to the uneven nature of the ground.

When these additions were made, I constructed a new line from Ipoh to Tapah Road; this was an iron line, and ran underneath the existing ones, which were of phosphor bronze, and when it had been up for three or four months we were troubled with many contacts, due to the phosphor bronze wires sagging on to the new iron line. The bronze wires were pulled up from time to time, but still

continued to sag, and this caused me to make an experimental span of phosphor bronze wire and watch it.

The conclusion I came to was, that the constant sagging had been due to the intense heat of the sun, which caused much expansion, and when the cool of evening set in (about 80° F.) the wires did not contract to their usual strain, and the little lost in this manner, day by day, soon became a serious trouble; I had, therefore, to alter the conditions by placing the iron lines above the bronze ones.

A great number of line faults are due to falling trees and small jungle fires on the railway side. In the case of copper lines, a falling tree almost invariably breaks them, but iron, being tougher, has a better chance of bearing the strain, and brings about the lesser of the two evils, *i.e.*, the binding wire at the insulator gives way, and the line falls to the ground unbroken.

In binding up lines in thickly jungled places it is, I think, profitable not to bind the lines too tightly or strongly to the insulators, so that in case of accidents the line may come away from the insulator unbroken, and enable communication to be kept up by additional battery power if necessary, till the damage is repaired.

In the case of swampy localities, nature exerts a compensating influence, and trees do not flourish in the water, therefore the line is spared the inconvenience of being put to earth—by falling trees, at least.

After a spell of very dry weather, say, for six weeks, everything becomes parched, and a spark from a passing train may kindle a fire. Though this is true in some cases, there is no doubt that many fires are produced by lazy natives (usually Malays), who cut the herbage on the railway banks by contract, and endeavour to earn their money by foul means, *i.e.*, by burning.

In instances like this the telegraphs almost always suffer, especially copper lines; but here, again, iron holds its own by standing the heat well and coming out of the fray little the worse.

(To be concluded.)

THE PRODUCTION OF MIXED CARBIDES OF MANGANESE AND CALCIUM.

It is well known that acetylene cannot be burnt satisfactorily for any length of time in small burners of the fish-tail variety, since the gas, however efficiently purified, more or less quickly yields a carbonaceous deposit at the orifices of the jet which disturbs the flame and causes it to smoke. In practice this objection is overcome by the use of injector burners which draw in a small proportion of air below the place of combustion, thus yielding a flame that does not actually touch the steatite or lava tips. Such a method of procedure, however, is theoretically defective, because the dilution of the acetylene with air wastes a certain percentage of its latent illuminating power. Another idea which has been suggested to avoid burner troubles is to dilute the acetylene with some combustible gas that contains a smaller proportion of carbon, or none at all, in place of the air which is so largely composed of useless nitrogen; but this has led to another difficulty, inasmuch as nearly all possible gaseous diluents burn at a temperature so much lower than that of the neat acetylene flame, that again its luminosity is reduced out of proportion to the advantage gained. The solitary exception hitherto discovered is methane, or marsh gas, which Prof. Lewes has already shown to be a suitable material for the dilution. Based upon this proposal for burning a mixture of acetylene and methane, the notion has arisen to prepare some carbide other than that of calcium, or some mixture of carbides containing calcium carbide, which shall decompose on treatment with water in a generator of the usual acetylene type to yield at once a gaseous mixture of acetylene and methane. Several metallic carbides evolve methane, or methane and hydrogen, on decomposition, among them being that of manganese; and the latter has the apparent advantage that it can be won in an electric furnace of the ordinary description, and at a much lower temperature (*i.e.*, with a lower expenditure of energy) than is necessary to produce calcium carbide. Accordingly a process was invented some years ago for treating a mixture of lime, oxide of manganese, and carbon in an electric furnace, which was reported to yield the desired mangano-calcium carbide, and this was followed by attempts—unsuccessfully it would appear—to exploit the method commercially. More recently, Mr. J. S. S. Brame and Prof. Lewes have tried some experiments in the same direction, reporting on them in the *Journal of the Society of Chemical Industry*. After some small laboratory tests which seemed to promise well, the research was continued with the assistance of the Acetylene Illuminating Company in the carbide furnaces at Foyers, using a plumbago crucible with a carbon electrode 6 in. square, and a current of 1,000 amperes at about 55 volts. Various mixtures of coke, lime, and manganese oxide containing up to 20 per cent. of the latter ingredient were submitted to fusion, which yielded spongy to crystalline ingots having net weights ranging from 0·16 to 0·34 lb. per KW.-hour; but on decomposition with water, these ingots gave gases containing 99·08 per cent. or more of acetylene, showing them to be practically pure calcium carbide without any manganese carbide. For some curious unexplained reason no trials were made upon raw materials containing between 20 and 60 per cent. of manganese oxide; but when a mixture of 27·72 per cent. of coke, 12·87 per cent. of lime, and 59·41 per cent. of manganese oxide was ignited with a low current density, a yellow ingot (0·34 lb. per KW.-hour) was obtained yielding 241 litres of gas per kilo—a gas which consisted almost wholly of methane and hydrogen, and which proved the product to be essentially pure manganese carbide. Another experiment with the same raw materials, but with a higher current density, gave precisely the same chemical result, the yield, however, being 0·80 lb. per KW.-hour. Thus the authors have, as yet, failed to produce in one operation a mixed carbide of calcium and manganese: an excess of lime in the furnace charge yields calcium carbide alone; an excess of manganese oxide gives pure manganese carbide. Still manganese carbide of high commercial purity could be made with a low expenditure of current if a demand for it should arise; and a mixture of manganese carbide with calcium carbide could be decomposed in a suitable generator, so as to evolve a mixture of acetylene, methane, and hydrogen, the heat of the reaction between the calcium carbide and part of the water being sufficient to determine the reaction between the remainder and the manganese carbide. In a paper published in the same journal last autumn, Tucker and Moody stated that it was impossible to win a mixed carbide of manganese and calcium, because the former compound requires quite different conditions for its formation than those which suit the latter. They only recovered their manganese as buttons in the metallic state. Messrs. Brame and Lewes dispute the accuracy of this last remark, which certainly does not seem to have been substantiated by chemical evidence. Brame and Lewes hold that the "buttons of metallic manganese" were in reality manganese carbide, and would have evolved gas had they been treated with hot water. According to Moissan, manganese carbide is decomposed by cold water, but the product obtained by Brame and Lewes only yielded to water at a temperature of 70° C. The experiments are to be continued with furnace charges intermediate in composition to those already tested; and the present authors hope to be able to prepare mixed carbides on a commercial scale, even if slight modifications in the method of working are necessary.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Oct. 1st, 1901.	Value £	Week ending Sept. 30th, 1902.	Value £
Amsterdam	140	Adelaide	538
Barcelona	1,571	Alexandria	73
Bombay	46	Amsterdam	22
Bordeaux	13	Bangkok	26
Boulogne	48	Bombay	557
Brisbane	16	Buenos Ayres	74
Calcutta	529	„ Teleg. mat.	329
Cape Town	221	Calcutta	57
„ Teleg. mat.	871	Cape Town	671
Christchurch	41	Channel Islands	10
Christiania. Teleg. wire	37	Chinde	20
Colombo	50	Copenhagen	108
Copenhagen. Teleg. wire	145	„ Teleg. wire	192
Demerara	90	Durban	1,565
„ Elec. motors	100	„ Teleg. apparatus	174
Durban	261	East London	21
East London	522	Foochou	451
Fremantle	488	Fremantle	176
Hong Kong	479	Gibraltar	86
Kobe. Teleg. cable	65	Gothenburg. Teleph. cable	127
Korsor. Teleg. cable	4,950	Halifax. Teleg. cable	18,489
Lisbon. Elec. launch	450	„ Teleg. mat.	187
Malta. Teleg. cable	74	Hamburg. Teleg. mat.	300
„ Teleg. mat.	400	Hong Kong	222
Melbourne	100	Kobe	53
„ Teleg. wire	224	Larache	123
Nagasaki. Teleg. mat.	6,500	Lisbon	35
Ostend	70	Melbourne	26
Penang. Teleg. mat.	268	Odessa	267
Perth	86	Perth	894
Port Elizabeth	33	Port Elizabeth	62
Rotterdam. Teleg. mat.	91	St. Petersburg. Elec. machinery	64
Shanghai	75	„ Teleg. mat.	874
Singapore	139	„ Teleg. wire	147
„ Teleg. mat.	369	Stockholm. Teleg. wire	144
Stockholm. Teleg. wire	84	„ Teleph. cable	65
Sydney	1,987	Sydney	470
Wellington. Teleg. mat.	209	Syra. Teleg. instruments	50
Yokohama	885	Yokohama	426
Total	£21,502	Total	£28,070

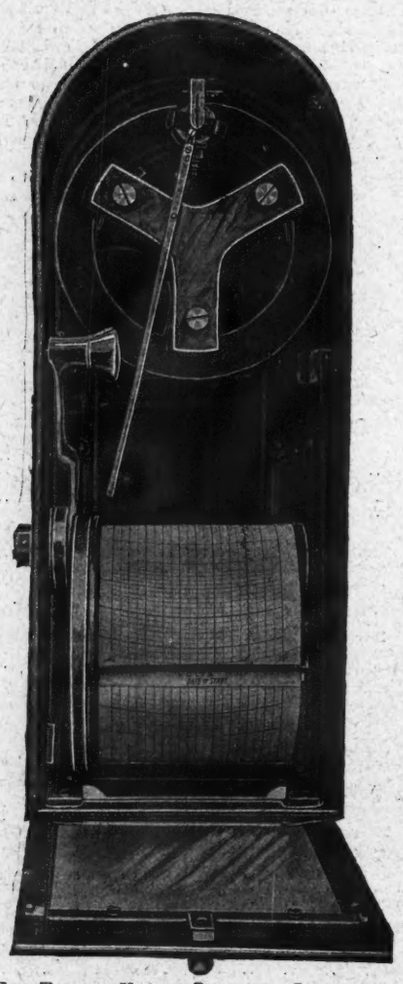
Foreign Goods Transhipped.

Gothenburg. Elec. apps.	Value £179

Nordrach Sanatorium.—Referring to the fire reported in our issue of 19th ult., it is interesting to learn that, notwithstanding the isolated position of the Institution and the precipitous hills over which it is reached (approximately 900 ft. above sea level), Messrs. Edwards & Armstrong, of Bristol, succeeded in installing within four days a plant of sufficient capacity to light the Sanatorium again.

Electric Power in a Small Arms Factory.—In the annual report of the Birmingham Small Arms Company, Limited, the directors say:—"To secure greater economy in working, the board is substituting electrical power for steam in the gun department, and already a set of engines and dynamos is erected, to be followed by two more sets. The old engines of about 600 H.P., which have been running for over 30 years, and are fully depreciated in the books, will be removed, and it is hoped that in a few months all the gun machinery will be driven by electricity. Other improvements effected at the works include the erection of an electric power house."

Recording Instruments.—Any improvement in the apparatus used in central station equipment which will obviate the necessity for careful manipulation and attention will be welcomed by electrical engineers. The time and attention of the charge engineer are largely taken up by the instruments used for recording the various factors in electrical supply; and owing to the progress which is being made in station cost-keeping, the demand for this class of instrument is continuously increasing, rendering necessary the employment of an instrument that can be placed in charge of an unskilled attendant. Messrs. Kelvin & James White, Limited, have recently placed on the market a new type of recording instrument (the invention of Lord Kelvin) in which the method of winding the clock and the changing of record sheets is accomplished in an exceedingly simple and ingenious manner. By a single movement of an operating handle the clock is withdrawn from its case and simultaneously wound for the next record, the movement being such that the clock drum passes out of contact with the pen to a position in which the paper may be changed without any possibility of fouling the pen. Another important feature of this instrument is that it is impossible to overwind the clock, even though the lever is repeatedly operated. This is accomplished by means of an automatic device which is thrown out of gear when the



New Type of Kelvin Recording Instrument.

driving spring is fully wound. The record sheet is 18 in. long, and the scale of the instrument about 4½ in., the clock making one revolution in 25 hours, thus allowing half an hour spare at each end. On the assumption that the instrument is attended to once a day, it has been thought inadvisable by the makers to provide a clock giving a longer record, as experience has shown that it is necessary to examine the clock at least once in 24 hours. They are prepared, however, to supply an instrument giving a longer record if required. A receptacle is provided inside the instrument for a year's supply of record sheets, and a file for the completed charts accompanies each instrument. The devices above referred to are fitted to all Lord Kelvin's recording instruments used in the measurement of amperes, volts and watts, on direct and alternating, single and polyphase circuits. The accompanying illustration shows the case open and the clock withdrawn into the position for fitting a new record sheet, the clock having been wound in the operation of withdrawal.

The Universal Microphone Co., Ltd., v. Nye.—In the Vacation Court on Wednesday last week, before Mr. Justice Jelf, the cases of the Universal Microphone Co., Ltd., *v.* Nye and another, and the British Microphone Co., Ltd., *v.* Nye and another, were mentioned. It was stated that the motions were for an interim injunction to restrain the defendants from parting with certain patents, but it had been arranged that they should stand over until the second motion day of next sittings. His Lordship agreed to this course.

Dissolution.—Messrs. W. A. Stevens and R. A. Barker (Stevens & Barker, electrical engineers, Maidstone) have dissolved partnership. Mr. Stevens continues the business under the old style, and attends to debts.

Trade Announcements.—Mr. G. Braulik notifies that he has again concluded arrangements with Messrs. Phillips & Co. for the sole sale of their incandescent lamps in this country for a number of years. He holds a very large stock of these lamps in all C.P.'s and voltages in readiness for the coming lighting season. Mr. Braulik has also made agency arrangements for the sale of the "Lux" electricity meters in the United Kingdom. The meter has a very extensive sale on the Continent.

The Southern Electrical Installation and Wiring Company, Limited, of 9, Claremont, Hastings, has purchased the businesses of Mr. F. Bruce, electrical engineer, Hastings, and Mr. F. Wordley, electrical engineer, of St. Leonards.

The Accessories Manufacturing Co. has removed to more commodious premises at 9 and 10, Wells Street, Oxford Street, W.

Books Received.—*Science Abstracts*, No. 57, September 25th, 1902. London: The Feilden Publishing Co., Ltd. 2s. net.

"Transactions and List of Members of the North-East Coast Institution of Engineers and Shipbuilders." Newcastle-upon-Tyne: The North-East Coast Institution of Engineers and Shipbuilders. 1902.

"Galvanic Batteries," by S. R. Bottone. London: Whittaker and Co. 1902.

"Merck's Index." Second edition. Darmstadt: E. Merck. 1902.

Educational.—The Day Colleges for Men and Women of the South-Western Polytechnic, Chelsea, began their new session on Monday last, September 29th, complete courses for the University of London degrees in science and engineering being provided.

Last Monday the courses of instruction in engineering and mechanical science for the winter session were recommenced at the Polytechnic School of Engineering in Regent Street.

A Hint.—Manufacturers of steam and electrical engineering machinery and plant, also electric fittings, apparatus and accessories, should send copies of catalogues, with a statement as to lowest prices and best discounts, to Mr. John Denham, electrical engineer of the Cape Government Railways, Cape Town.

American Exports.—The value of the electrical machinery and apparatus (including telegraph and telephone instruments) exported from the United States during July last amounted to £167,133, as compared with only £126,376 in July, 1901.

Rubber.—It is reported that a United States Rubber Co., with £1,000,000 capital, is to control the Bolivian rubber territory, which may be made to produce 12,000,000 lbs. of rubber annually.

Catalogues and Lists.—The Reason Manufacturing Co., Ltd., has issued an excellently got-up pamphlet describing the Wright patent electrolytic meter fully, with the aid of a number of diagrammatic and other pictures.

The London and Colonial Export Co., of St. John's Hill Grove, S.W., has taken over the business of Mr. A. Stanford Wright, of New Wandsworth, together with his branch offices in India, South Africa and New Zealand. We have received a copy of the company's new catalogue of electric lighting supplies, fans, bells, &c. Mr. Stanford Wright will act as managing director to the company.

From Herr Max Kohl, of Chemnitz, we have received a circular describing his new alternating current redresser, by means of which it is possible to charge accumulators directly with the alternating current of a central station. A specially constructed type of this apparatus is designed to work induction coils directly with an alternating current without the application of an interrupter.

New circulars have been sent out by Messrs. McPhail & Simpson's Dry Steam Patents Co., Ltd., of Wakefield, relating to their patent wrought-steel steam superheater. A spare sheet gives a tabulated list showing the results of tests made by independent experts.

The Peerless Rubber Manufacturing Co., of New York, have sent us a small booklet detailing a number of their engineering specialities, such as packing, belting, hose, &c.

Messrs. G. Straus & Co., Ltd., of Upper Thames Street, E.C., who are the London representatives of the Aix-la-Chapell Steel Works, have placed before us lists of automobile motors and their "Fafnir" motor engines.

Halifax.—A smart piece of work was performed by the Corporation electricity department on September 22nd. The engines at a large factory broke down, and on Wednesday morning 60 yards of cable had been laid and a large motor fixed and connected. By the following Thursday another large motor was fixed and the whole of the mill placed in full working order. Without the aid of electricity the mill would have had to stand idle for two or three weeks. We shall not be surprised if that engine never is repaired!

THE MAKING OF A DYNAMO.*

By HENRY A. MAVOR, M.I.E.E., M.Inst.C.E.

Dynamos and motors are familiar objects of daily use, but to the millions of passengers by electric cars and users of electricity, and to engineers generally, who are not specially engaged in the applications of electricity, it may be of interest to follow the dynamo machine through the course of its construction in the workshops.

There are therefore here submitted a series of photographs taken in the works and showing various processes of manufacture, which will serve as a text for a few observations on various points connected with the construction of electric machinery generally. The illustrations are concerned with the manufacture of continuous-current machines, but the same methods of construction are applicable to alternators, and the principles of mechanical and electrical design in

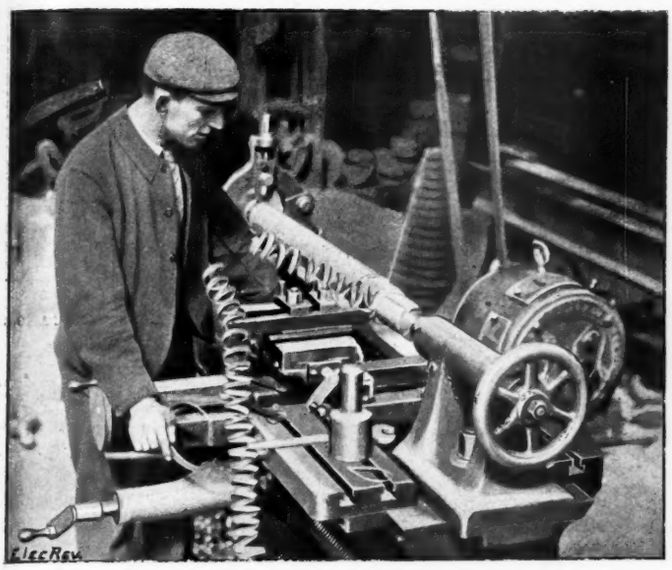


Fig. 1.—Rough-Turning Shaft.

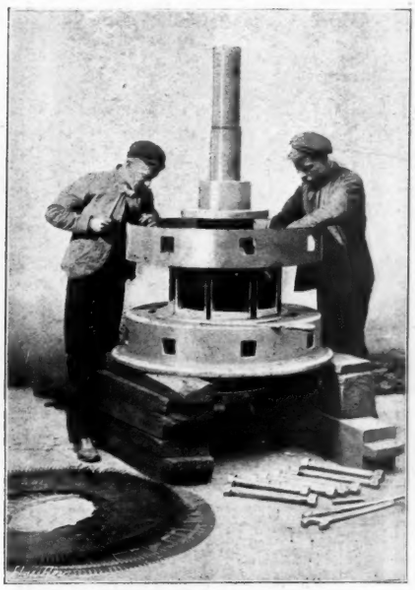


Fig. 2.—Shaft and Spider.

Fig. 4.—Building up Commutator.

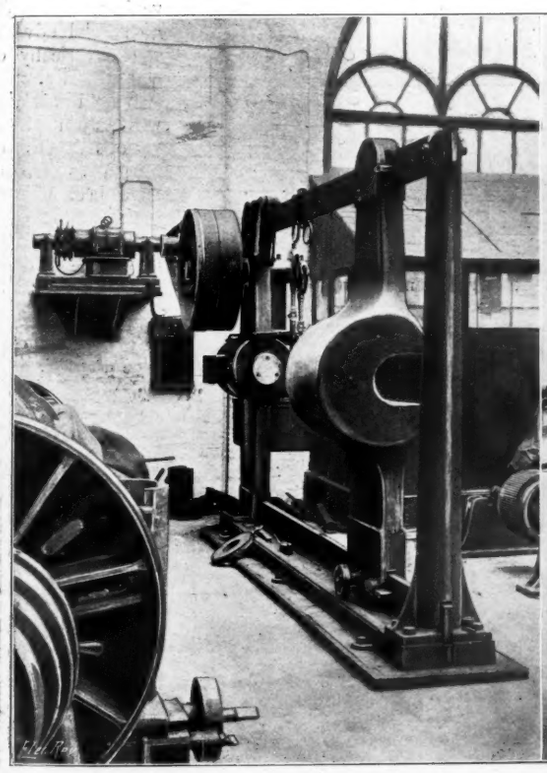


Fig. 3.—Hydraulic Press.

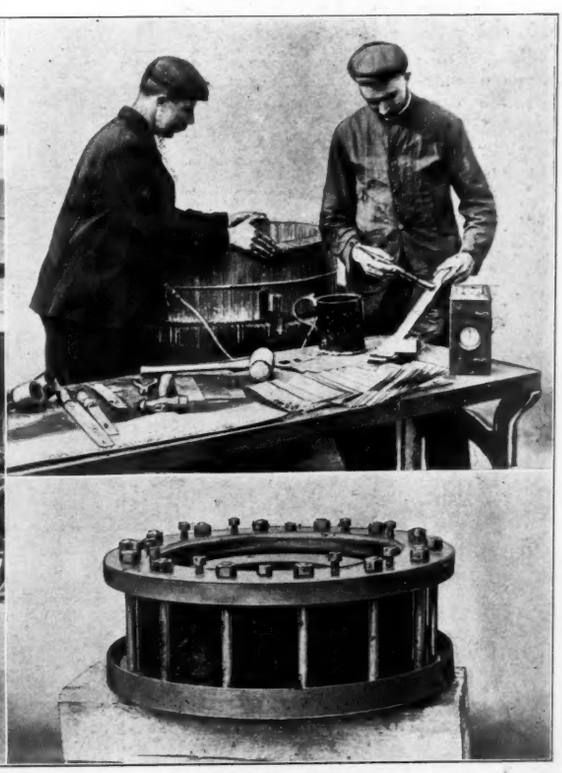


Fig. 5.—Commutator Centre.

* Abstract of a paper read before the meeting of the British Association, Belfast, September 16th, 1902.

both cases are the same. The dynamo machine, or motor, being an apparatus for rotating armature conductors in an electric field, the form of the electromagnet naturally claims early consideration. The tendency of the present day, from the smallest to the largest machines, is to adopt a multipolar type, which has the advantage of being on the whole cheaper and more convenient to manufacture, and somewhat more compact in form, than the bi-polar type, which was until a few years ago universally adopted in this country. There is likely, however, to be a reaction from this tendency in favour of bi-polar machines for the smaller sizes for the electromotive force usually adopted for public supply. A bi-polar machine of, say, 5 H.P. for a 500-volt circuit is more suitable than a multipolar; whereas, on the other hand, for large currents a multipolar machine is much the better, the proper diameter for the armature being nearly directly proportional to the current to be taken from it; in bi-polar machines large diameters are expensive and inconvenient, and offer no special advantage electrically or mechanically.

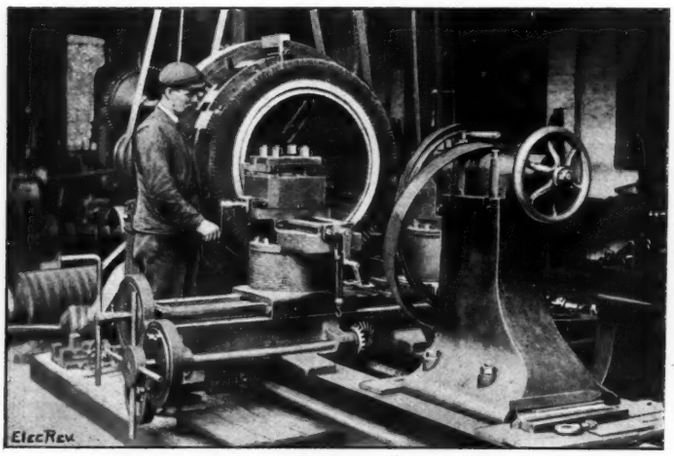


Fig. 6.—Turning Groove in Commutator.

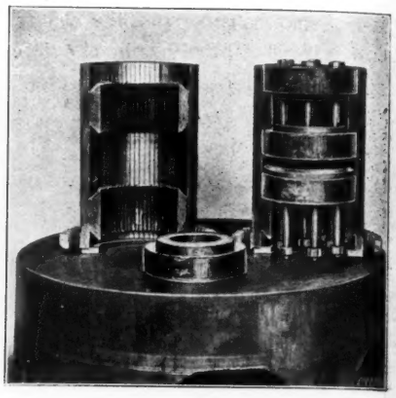


Fig. 7.—Construction of Long Commutator.

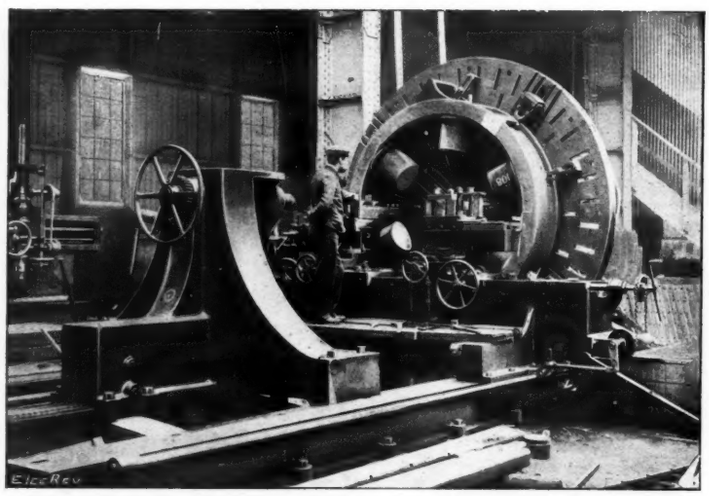


Fig. 8.—Boring Out Magnet Ring for Pole Shoes.

An illustration was shown of the various types of magnets which have been evolved in the past, together with illustrations of various processes of manufacture which, not being special to dynamo machines, need not be reproduced here.

Fig. 1 shows the operation of rough-turning a dynamo

Fig. 9.—Drilling Bolt-Holes in Pole-Pieces.

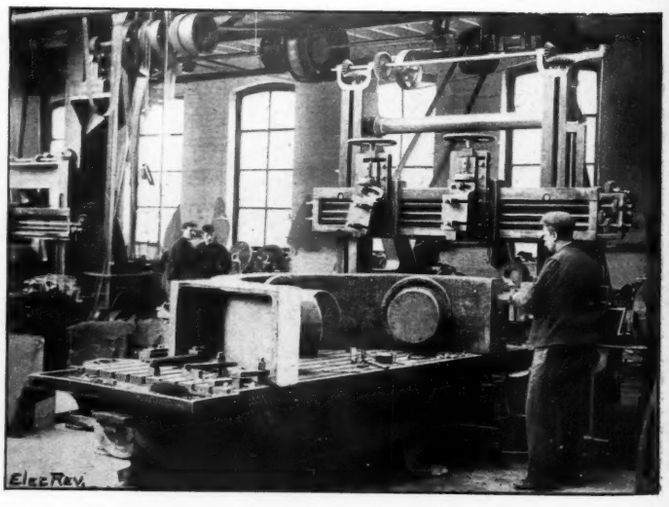


Fig. 10.—Facing Joint of Magnet Ring.

shaft, and attention is specially directed to the facility with which an existing lathe has been modified by the application

Fig. 11.—Winding Magnet Coil.

Fig. 13.—Insulating Armature Conductors.

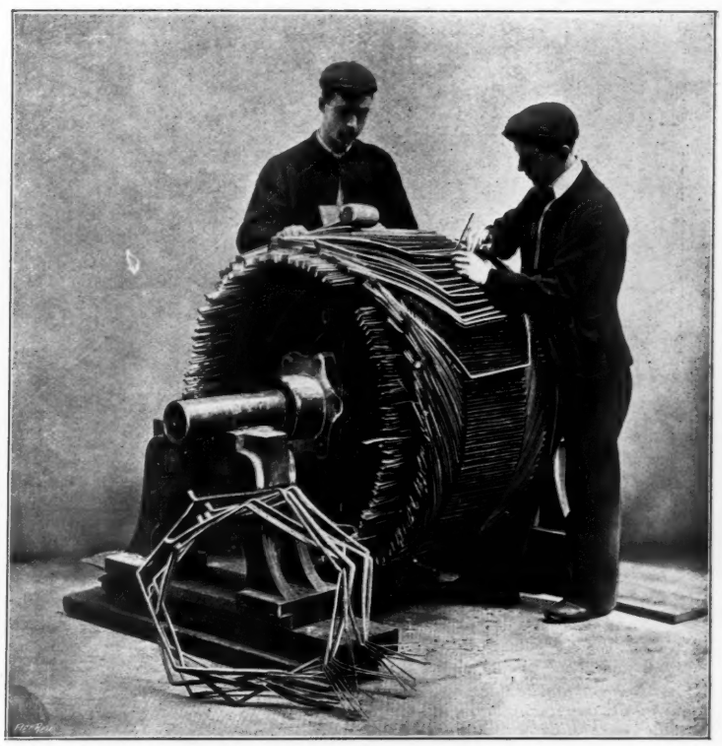


Fig. 14.—Winding Drum Armature.

of special arrangements of electric driving, so as to run at the high speeds now rendered possible by the introduction of

Fig. 15.—Winding Large Drum Armature.

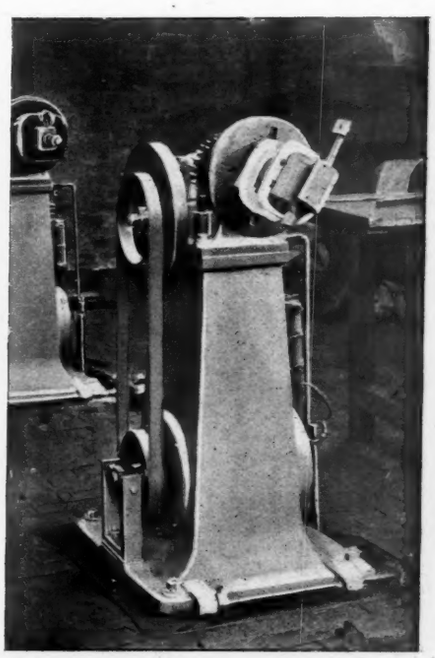


Fig. 12.—Automatic Magnet Coil-Winder.

steel tools with a high rate of cutting. The turning shown in the illustration was effected at the rate of 82 ft. per minute, though with lighter cuts a cutting speed has been attained of 200 ft. per minute, and in this connection it is important to note the bearing of the premium system on the introduction of such improvements in manufacture. Much trouble is experienced in introducing such an improvement as the use of high cutting speeds where the workman is not

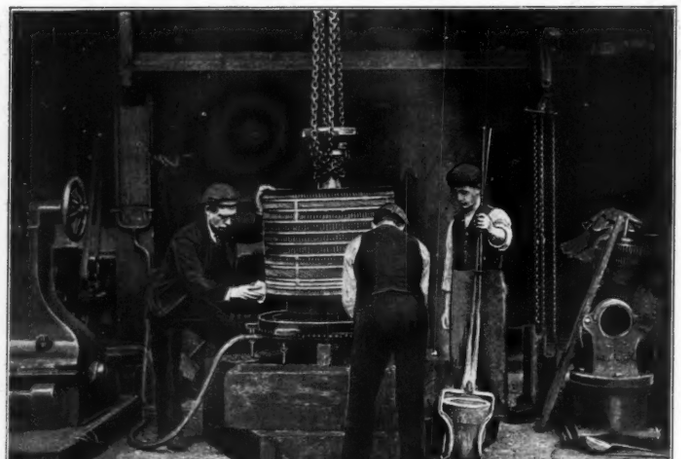


Fig. 16.—Soldering Commutator Lugs.

directly interested in the success of what is, in the first instance, an experiment. The introduction of the new method of cutting in the particular case illustrated has resulted in the workman earning a premium of as much as 67 per cent. on his daily wage—a very substantial inducement to use the new method. This has resulted in a demand on the part of the workmen for more expeditious means of handling work. The time actually employed in cutting has become relatively unimportant as compared with the time of handling and placing the job in the lathe.

Another view which was shown illustrated a machine for grinding shaft journals, so as to ensure regularity and perfection in the work. Here, again, the introduction of a new method has resulted in much improved returns to the workmen, as well as in a great reduction of the cost of manufacture.

Fig. 2 shows the shaft mounted with the cast-iron "spider" and end-plates, ready for the reception of the core discs, which are shown on the floor at the men's feet. The importance of a rigid and thoroughly sound mechanical support for the armature conductors is now fully recognised, and many troubles formerly incident to the use of machines of the larger diameters are now entirely obviated by attention to this important point.

The practice in Germany with regard to the quality of iron used in the cores of continuous current machines is worth notice at this stage. The German manufacturers appear to find that in the large sizes it is not necessary to pay such scrupulous attention to the quality of the armature iron as has been customary in this country, with the result that a cheaper quality of plate is now very largely used, and a corresponding reduction gained on the cost of the machine.

Fig. 3 shows a convenient form of hydraulic press for squeezing up the

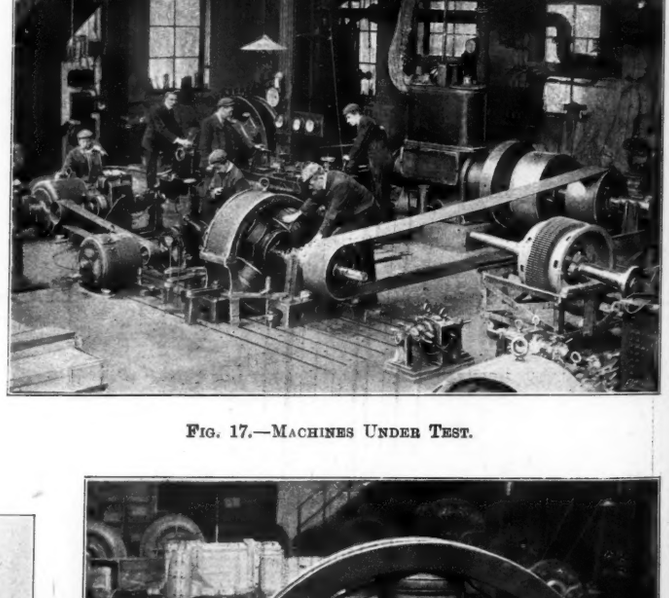


Fig. 17.—Machines Under Test.

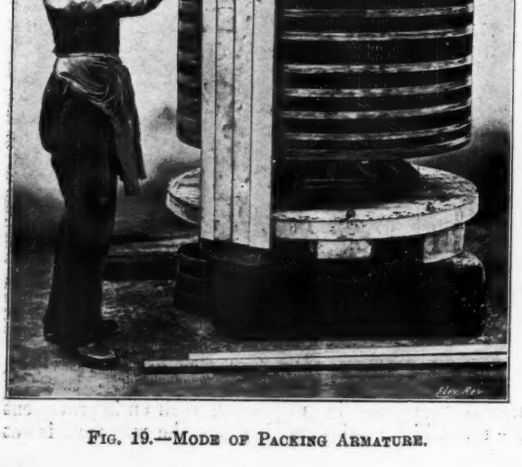


Fig. 19.—Mode of Packing Armature.

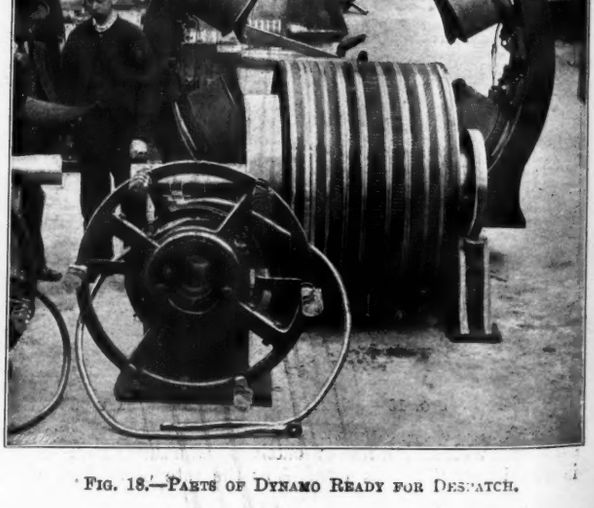


Fig. 18.—Parts of Dynamo Ready for Despatch.

armature cores on the smaller sizes of machines, and for use in building commutators.

Fig. 4 illustrates the method which is in almost universal use for the construction of commutators. The illustration shows the first assembling of the commutator plates, with their insulating segments.

Fig. 5 shows a commutator sleeve, in which the ends of the sleeve form as it were the hoops of the barrel into which the commutator segments are built.

Fig. 6 shows the operation of turning the groove for the reception of the hoops. Hung over the back head of the lathe are the insulating rings, which are interposed between the groove in the copper segments and the steel hoop. Another view showed the commutator complete and under test for faults produced in turning or handling.

Fig. 7 shows a special form of commutator adopted for heavy currents, where the commutator blades have to be of an abnormal length. In this case a pair of hoops are inserted in the middle of the commutator.

Fig. 8 shows the operation of boring out the magnet ring for the reception of the pole shoes, which are shown in place in fig. 9.

Fig. 10 shows the operation of facing the joint between the two halves of the magnet ring on the planing machine. This is almost the only operation left in the construction of a multipolar machine for the plane to perform, and has resulted in a considerable change in the equipment of electrical shops in this respect, the entire disappearance of the large planed surfaces having rendered unnecessary the use of large planes and slab milling machines.

Fig. 11 shows the operation of winding a magnet coil for a multipolar machine. Fig. 12 shows a special machine for the purpose of winding magnet coils with automatic reversing and stop motion (Messrs. Crompton & Co.).

Fig. 13 shows the process of insulating the armature conductors preparatory to their being mounted on the armature. The ingenious machine which is in use for this purpose has resulted in a very great saving in labour. The skill in working it is rapidly acquired, and here again the workers are enabled to materially increase their earnings, while improving their work and reducing the cost.

Fig. 14 shows the armature winding under construction.

Fig. 15 shows a larger machine at the same stage. It is found more convenient to mount the larger machines as shown in this figure, so that a greater number of hands can be applied to the work. This figure shows also the method of securing the conductors in the slots of the core by means of hard wood keys—a method which is perfectly satisfactory with peripheral speeds up to about 6,000 ft. per min., but for higher speeds the method adopted by Messrs. Parsons is the only one available, viz., the sheathing of the whole winding in a banding of pianoforte wire from end to end of the core.

Fig. 16 shows the method of making the joints between the armature winding and the commutator. As usually performed, this is a tedious and somewhat dangerous operation because of the risk of fire. The method shown is one in which an annular pot containing the molten solder is used, with a gas flame underneath to keep it hot. The solder is heated to a very high temperature, and poured into this ring, and the armature is lowered into it from above, the commutator passing through the opening in the pot, and the joints dipping into the solder. The form of the commutator lug is modified to suit this method of jointing, having a recess to admit the inner lip of the solder pot. On the larger sizes the work is performed in a similar manner, but in sections of about 20 joints at a time.

After this operation has been completed, pieces of insulating material are inserted between the lugs of the commutator, and the whole is bound down on the top with steel wire.

A special form of drying stove is used for the treatment of armature and magnet coils. The stove is heated by steam, and the air is exhausted from it by means of a pump, so that the drying is done in vacuo.

Fig. 17 shows a group of machines under test.

Fig. 18 illustrates the principal parts of a direct-coupled machine, ready for despatch.

Fig. 19 illustrates the method of packing the armature for transit.

This series of illustrations was followed by a group of typical dynamos and motors, including machines of the largest sizes driven by low and high-speed engines, and by Parsons turbines, also a small plant, which has already been illustrated in this journal, showing an automobile engine coupled to a dynamo, forming a very small and complete plant for export purposes.

The majority of these illustrations are from photographs taken in the works of Messrs. Mavor & Coulson, Limited, Mile End, Glasgow.

ELECTRIC LIGHT AND POWER NOTES.

Barnstaple.—The T.C. has decided to have the electric light installed in all the public buildings.

Bexley.—On Messrs. Mordey & Dawbarn's recommendation, the U.D.C. has passed a resolution that application be made to the L.G.B. for a loan of £15,493, instead of £15,000, in respect of electric lighting.

Birkenhead.—The T.C. Electricity Committee has decided to provide the public with electric motors on a simple hire or hire-purchase system, with the following charges for energy:—For the first 500 units per quarter, 2½d. per unit; for additional units, up to 1,500, 2d. per unit; beyond 1,500, 1½d. per unit.

Blackpool.—The T.C. on September 23rd appointed a deputation to visit certain towns where cooling towers are used at generating stations, with a view of adopting one at the Corporation's electricity works.

Bristol.—The B. of G. has decided to have the new workhouse infirmary wired and fitted for electric light, and to have electric bells, telephones and electric motors provided, at an estimated cost of £5,580.

Burslem.—The T.C. on September 25th decided to apply to the L.G.B. for a loan of £31,000 for the provision of an electric light installation, and a deputation was formed to wait upon the B. of T. with a view of obtaining further time in which to carry out the work, as the present electric lighting order expires on October 28th next.

Colne.—The new electrical generating station of the Borough of Colne, Lancashire, was opened on Thursday last week. The Mayor of Colne, Alderman W. H. Varley, with Councillor H. Hewitt, chairman of the Electrical Committee, and a number of councillors and guests assembled at the generating station, and the Mayor called upon Councillor Hewitt to perform the duty of opening the building. Councillor Hewitt said that they were under agreement to supply the Colne and Trawden Light Railway Company with electrical energy, and they hoped the company would prove a very useful customer. Mr. Cooper, electrical engineer, had carried out the work, and the borough surveyor, Mr. Hartley, designed the buildings.

Mr. Hewitt then started the steam engine and generator. Votes of thanks were passed to Councillor Hewitt and the Mayor, and the ceremony terminated.

In the evening, Councillor Hewitt entertained a large party at the Crown Hotel in celebration of the opening of the station. The chimney is 175 ft. high, with an internal diameter throughout of 6 ft. The steam pipes are coated with Joseph Petty's pipe covering. The supply of electricity was begun in September, 1901, from a destructor station near the new generating station. The Colne and Trawden Light Railway Company is about to construct electrical tramways for the town and locality, and has arranged to take its supply of electricity from the Council to the extent of a maximum of 200,000 units at 1¾d. per unit, and any further amount which may be required at 1½d. per unit.

The new generating house is 53 ft. × 38 ft. The principal machine which it contains is a 240-H.P. compound vertical Belliss engine, running at 380 revolutions with steam at 160 lbs. pressure, and driving a Greenwood & Batley compound-wound six-pole dynamo, 310/290 amperes 500/550 volts. There are also two Siemens boosters and a Siemens balancer, the latter capable of dealing with an out-of-balance load of 100 amperes. The switchboard was constructed from Mr. Cooper's design; it consists of nine marble panels, and has been erected by Messrs. Cowans, Limited, of Salford. There are two generator and three feeder panels, with Cowans' patent field switches, B.T.H. magnetic blow-out circuit breakers, Thomson watt-hour meters, and Crompton-Ashley ammeters and voltmeters. The mid-wire panel has a B.T.H. circuit-breaker, an Elliott Bros.' earth-recording ammeter, and two Crompton ammeters. The bus-bar panel is arranged to plug horizontally, with positive plugs at the top, negative at the bottom, and mid-wire in the centre. The battery panel has Crompton-Ashley dead-beat voltmeter, Elliott Bros.' recorders, Thomson meter, and switches for charge and discharge. The engine house is provided with an overhead travelling crane of Messrs. Rushworth Bros.' manufacture.

A suite of offices is situated at one end of the building. In the basement below the offices is an accumulator house, 53 ft. × 24½ft., containing a battery of 270 cells, with 31 pasted plates in each. The capacity is 270 KW. on a 60 amperes discharge for 9 hours.

The regulating cells are connected with the switchboard by means of copper rods, ½ in. in diameter. The battery was supplied by the British Power, Traction and Lighting Company, of York.

The boiler house is 53 ft. × 49 ft., and will provide room for three boilers, economisers and accessories. One Lancashire boiler, 30 ft. × 8 ft., of Yates & Thom's manufacture, is at present installed. Stoking will be done by a Proctor sprinkler stoker, and a Hick, Hargreaves superheater is provided. A Green's economiser is provided, and one of J. P. Hall & Son's direct-acting vertical pumps. The steam engine is intended to be worked condensing, and a Körting ejector condenser has been provided. This is supplied with water from the River Calder by two electrically-driven centrifugal pumps.

The older plant at the destructor station consists of a 150-H.P. Parsons turbo-generator, which generates at 480 volts for lighting, and at 500—550 volts for traction. It is run at 3,300 revolutions, with steam at 120 lbs. pressure, and is fitted with automatic brush regulating gear. A Körting condenser is also used with this machine. The dynamo, worked by the turbine, is a two pole Siemens machine. Steam is supplied by a Babcock & Wilcox boiler, and is passed through a superheater of the same company's make. About 80° to 100° F. of superheat is obtained. A pumping chamber has been constructed on the bank of the river to supply water for both stations. In this chamber are two De Laval centrifugal pumps, one capable of lifting 460 gallons a minute against a head of 55 ft., the other capable of delivering 230 gallons. The pumps are worked by two Greenwood & Batley electric motors, of 18 and 9 H.P.

Distribution is effected on the three-wire system at 480 volts across the outers. The distributors are three-core, paper-insulated cables, ·02 and ·025 in. in section. The feeders are ·4 and ·2 in. section, triple-concentric. All have been made by the British Insulated Wire Company, Limited. The present lighting capacity of the plant at both stations is 5,200 8-C P. lamps. The charges for lighting are 6d. for the first hour, and 2½d. afterwards, or a "flat rate" of 4½d. per unit, for any quantity of current used. For power, 2½d. per unit is charged for a daily use of four hours, and also on a sliding scale which works out to about 1½d. per unit for 10 hours.

The cost of the new station has been about £24,000, made up of the following main items:—Land, £1,200; building, £5,100; accumulator, £1,000; mains, £8,000; and machines and boosters, £8,000. The contractors for the building were the trustees of J. M. Hawley; for the ironfounder's work, Messrs. Cross & Cross; and for the chimney, which cost £1,129, Messrs. Smith Bros., Ltd.

Mr. A. G. Cooper continues as electrical engineer-in-charge of the two stations, with Mr. H. N. Nugent as assistant engineer.

Cowes (I.W.).—Regarding the Electric Lighting Company's scheme for laying mains and street boxes in the town, the U.D.C. has decided to represent to the B. of T. the necessity of the Council having some sort of supervision over the work at the expense of the company, so that the present gas and water services can be protected from injury.

Devonport.—The accounts of the borough electricity works, which have been in operation since May 23rd, 1901, covering a period of 10 months, show that the gross profit amounts to £1,460. The capital charges are £3,328, leaving a net deficit of £1,266.

Dublin.—On Saturday afternoon the Irish Section of the Institution of Electrical Engineers—mustering about 50 members—visited the new electric station of the Dublin Corporation at the Pigeon House Fort, and was shown over the works by the officials of the works and the Corporation. Mr. W. Brew, assistant of Mr. Hammond, explained the works.

Dumfries.—On Tuesday last week a special meeting of the T.C. was held for the purpose of again considering the question of the introduction of electric light into the burgh, and of running an electric tramway to Glencaple. The cost of the tramway scheme is estimated at £38,000. It was ultimately decided to wait till after the annual elections in November before embarking on a scheme.

Edmonton.—At a meeting of the U.D.C. last week it was resolved to offer Messrs. Hammond and Hawtayne a fee of 50 guineas each to submit reports on and estimates of the cost of schemes for carrying out the recently obtained provisional order.

France.—The municipal authorities of Grenoble have granted a concession to the Société Electro-Chimique de la Romanche for the supply of electrical energy for lighting and power purposes in the town during a period of 45 years.

Gloucester.—At a T.C. meeting on September 25th it was reported that many more applications for the light and for an extended service had come in, and the output of the works had increased by 12 or 13 per cent. in 12 months.

Leicester.—The extensions of the electric lighting plant authorised by the Corporation some time ago are now in progress, and the first of a couple of Lancashire boilers, made by Messrs. Grimson, of Leicester, was delivered to the works on Saturday. The boiler is 30 ft. long by 8 ft. 6 in. in diameter, and weighs nearly 20 tons; while about midway between the foundry and the gas works the wheels on one side of the trolley on which it rested crashed through the road, breaking down the top of a sewer, and it necessitated between two and three hours' work to get it on the road again. The second boiler will be delivered in a fortnight, it is to be hoped without a repetition of the disaster.

Leicester.—The accounts of the electric lighting department for the half-year ended June 30th show a surplus, after paying interest on the capital of the undertaking, of £4,563 3s. 3d. For the corresponding period of 1901 the surplus was £2,065.

Liverpool.—A Committee of the T.C. has been appointed to consider the procedure with respect to contracts of the electric supply department, and to report to the Council respecting the same.

Luton.—The T.C. has resolved by a majority of one to apply to the L.G.B. for leave to raise a further loan of £5,000 for extensions of mains, &c.

Macclesfield.—A proposal from Messrs. Medhurst, Page and Lloyd, of Manchester, with regard to the electric lighting of the town, has been referred to a committee, which has been deputed to visit other towns, for consideration.

Penzance.—The T.C. has obtained from Mr. C. A. Baker, engineer of the Cornwall Electric Power Company, comparative figures showing how a supply of energy from the company would compare in price with the figures given to the Council by Mr. Trentham.

Sale.—The laying of the cables for the electric lighting of this district is now almost completed. The energy will be supplied in bulk by the Trafford Power and Lighting Co., and it is expected that the local authority will start with a fair list of consumers.

Scunthorpe.—The U.D.C. on September 25th decided to promote a Bill authorising the Council to manufacture and supply electricity for all public and private purposes in the district.

Sheerness.—The Electrical Power Distribution Company intends to apply for powers to extend its mains from Sheerness East to Milton and Sittingbourne.

Stoke-on-Trent.—The T.C. on September 25th adopted a scheme for the construction of an electric light station and a refuse destructor, and the surveyor and electrical engineer were instructed to prepare the necessary drawings and specifications.

Totnes.—The T.C. on September 24th discussed letters from the B. of T. and the Totnes Electricity Supply Company relative to the Totnes E.L. Order, 1900, which, the B. of T. stated, the undertakers had failed to carry out in the prescribed time. The Electricity Supply Company had asked the B. of T. to give it further time, as negotiations were in progress with a view to making the deposit specified, and to erecting and equipping the station without delay. In a letter to the Council, the company asked the Corporation to agree to a reasonable extension of time. It was decided to inquire what terms the company was prepared to come to if an extension were allowed.

Wallasey.—The Gas and Electricity Committee of the District Council has recommended that the Council apply to the L.G.B. for sanction to borrow a further £52,350 for extensions of the electrical plant. The electrical engineer (Mr. J. H. Crowther) recently prepared for the Council an estimate of the probable requirements at the generating station during the next seven years. The above-named sum was decided upon by the Committee to provide for those requirements. The Committee recommends that the charge for electricity to the Tramways Committee be 1§d. per unit instead of 2½d., and that to consumers of energy for lighting in the district a reduction be made in the quantity now required to be consumed before coming on the lower scale; also a reduction of 1d. in the lower scale, viz., from 4d. to 3d. per unit, but the initial price of 6d. to continue. The cost to the Council of the repairs to cars and overhead equipment, which are being done by the Council's staff, is about £250 per annum.

Weardale.—The U.D.C. is negotiating with a private company for lighting Wolsingham by electricity.

Wirksworth.—The Derby and Notts Electric Power Company has informed the U.D.C. that it contemplates putting up a generating station near Matlock for the Matlock and Wirksworth districts, and another station near Ilkeston, for supplying power for the tramway and general lighting. The charge will be 1½d. per unit for 250,000 units. The mains will have to be put in by the Council at an average cost of about 7s. 6d. per yard, and the transforming apparatus, which would cost £500 or £600, could be provided by the Council, or the company would do it and charge a percentage. If done by the Council a prov. order would be necessary, but the company would bear the cost. The Council has asked the company to submit a list of charges, &c.

ELECTRIC TRACTION NOTES.

Altrincham.—The result of the poll taken in this township on the question of electric tramways had been declared. The number of voting cards issued was 2,874, of which 1,386 were returned. There were 894 votes in favour of the scheme, and 473 against. Of those in favour, 712 supported the carrying out of the scheme by the District Council, and 182 by a private company.

Birmingham.—Representatives of a number of local authorities held a conference on Friday on the tramway question, and a resolution was passed to the effect that it was desirable that the authorities outside the city should combine for the purpose of dealing with the tramway question.

Bolton.—The Corporation Tramways Committee has decided to include in the next Parliamentary Bill powers in respect to the Horwich electric tramways. It has also been decided to connect the borough tramways with the East Lancashire system.

Bromley.—The chief engineer of the B.E.T. Co. has informed the U.D.C. that he is preparing a scheme of electric tramways for submission to the Council. When the matter came before the Council on September 24th, opinion was in favour of the Council preparing a scheme of its own. The matter was referred to a committee.

Chatham to Gravesend.—At the meeting of the Strood D.C. last week, a letter was read from Messrs. Ashurst, Morris, Cripps & Co., of London, the solicitors to the Chatham and District Light Railways Company, stating that their clients had been asked to consider the possibility of constructing a tramway system to connect the company's existing lines at Chatham and the district with the town of Gravesend (a distance of some 8 miles). Before coming to a decision in the matter they would like to ascertain as far as possible the attitude of the authorities principally interested in the matter. The matter was discussed by the Council and Mr. Thos. H. Baker, J.P. It was resolved that the Council viewed the proposal very favourably, and would do all it could to assist the matter on.

Crowland.—The R.D.C. has decided to oppose the application of the promoters of the Crowland and District Light Railway for an extension of time for constructing the line, with the object of securing a more favourable proposal.

Dartford.—The U.D.C. on September 25th decided to obtain advice from Mr. Hawtayne, its consulting engineer, with respect to the provision of electric trams for the town. Opinion was in favour of a private company undertaking the work in preference to the Council, which has just provided an electric light installation.

Devonport.—A child of five was killed by an electric car on the Plymouth, Devonport and Stonehouse system last Saturday.

On the same day on the Devonport and District lines, at Plymouth, a serious accident occurred to a car which got beyond the driver's control, and led to the death of one person, and injury to eight others. The car was descending the incline leading to the S. W. Railway station, but the application of the brakes failed to stop it, and at the foot of the slope, where the line takes a sharp curve into one of the main roads to Devonport, the vehicle, which had by this time attained a terrific pace, jumped the rails, crossed the road, and dashed into a wall enclosing the carriage entrance to the station. The force of the impact broke the wall, and caused the car itself partly to topple over. Some of the passengers on top jumped into the roadway, and others were thrown off. Mr. Chope, a dentist's assistant, in jumping off, succeeded in clearing the car and the wall, but as he alighted in the roadway, which slopes down to the entrance to the station, a piece of granite coping weighing several hundred-weight, dislodged by the force of the collision, fell on his head, death being instantaneous.

It appears that in June last a car left the rails at the same spot and damaged the station-wall. The Tramway Committee on Saturday resolved to ask the Board of Trade for an immediate inquiry into both accidents.

At the inquest which was opened at Devonport on Monday into the death of Mr. Chope, the Coroner intimated that he should adjourn the inquiry for a week. The foreman said some of the jury were of opinion that it was really dangerous to use the section of the line where the accident occurred, and they thought that, until a Board of Trade inquiry had been held, the cars should be stopped at the top of the hill and passengers transferred to another car at the bottom. There had already been three accidents, which showed the section, though short, to be a dangerous one. Another juryman said that it was not the first time that an accident had occurred at that particular spot, and it was a great mercy that a more serious accident had not happened before, especially when some 100 or 120 dockyard workmen were riding on the cars. The Coroner replied that it would be rather unwise at that juncture to pass any recommendation without having heard any evidence in the case.

Eccles.—The Parliamentary Special Committee of the Corporation has recommended the payment to the Salford Corporation of £20,000 on account of expenses incurred in the reconstruction of the Eccles tramlines and their adaptation for electrical traction. The tramway from Eccles to Peel Green is to be opened for traffic on October 3rd. The line connecting the borough with Pendleton, *viâ* the Eccles Old Road, is also completed. The Salford Corporation wants certain alterations made in the construction of the lines in Eccles, on the circular route to Patricroft, but the Parliamentary Committee of Eccles cannot agree with it. The Salford Corporation has been informed that it must bear the sole responsibility for any alterations, made during the progress of the work, where a departure from the terms of the agreement is involved, unless the written sanction of the Eccles Committee is first obtained.

Exeter.—The T.C. on September 25th decided to take steps to obtain powers to construct electric tramways in the city. The Electric Traction Committee recommended a route of nearly seven miles, at an estimated cost, including overhead equipment, of £6,500 per mile, but it was decided also to construct other lines from Exe Bridge to Redhills, and in South Street.

Gloucester.—The Council on September 25th confirmed the agreement for the purchase of the undertaking, &c., of the City of Gloucester Tramways Company, Limited, for £26,000, and decided to ask Board of Trade sanction to a loan.

Kendal.—The T.C. has received from the Electric Haulage Co., of London, an offer to supply on approval, for six months, one of their 1902 type of road cars for 24 passengers, and fit up at their expense a mile of two-wire overhead line, to be connected to the Corporation electric feeders. After the probation period the car and line, if satisfactory, would be purchased by the Corporation at £1,800 per mile of line and £600 per car; and if unsatisfactory they would remove both at their own expense. A sub-committee has been appointed to fully consider the proposal.

Lancaster.—At the T.C. meeting last week Mr. Alderman Smith, chairman of the Electric Tramways Committee said that the routes to Scotforth and the Park were practically completed, and about 10 cars were ready, but there was no power to drive them. The machinery was ready for delivery, but the buildings had not been ready to receive the plant. Mr. Councillor Heald, chairman of the Electricity Committee, intimated that the first unit of the generating plant would be delivered last week. It was mentioned in regard to the Lancaster and Morecambe route that a definite offer had now been received from the Lancaster and District Tramway Company of the sale of their interest in the horse traction line. This will be considered by the Committee at their next meeting. It is recognised that unless Lancaster is joined to Morecambe the tramways will not be the financial success which is desired, but the negotiations hitherto have not been conducted in a very diplomatic manner. The contracts for the lengths of tramway now completed, about two miles with the cars sheds and station, amounted to about £23,000, and the work has been carried out under the personal supervision of Mr. W. A. Tester, electrical engineers.

Llanelly.—The British Insulated Wire Company has made arrangements with another firm to take over the electric traction for Llanelly, and an early completion is promised.

Macclesfield.—The T.C. has received notice from a private company of its intention to apply to Parliament for powers to construct a line of electric tramway in the borough in three years, and without the borough in five years. The company proposes to take its electrical power from the Corporation if it is prepared to supply it; if not, it will seek powers to generate its own energy. As the present railway accommodation is inadequate, the scheme is meeting with favourable consideration.

Manchester.—Our Manchester correspondent writes:—"The Corporation is making a profitable business of its tramways. After all working and other expenses have been met there will remain, upon the past year's working, a disposable balance of £30,000. Allowing for interest on the mortgage debt, sinking fund, and instalment of loans, the Tramways Committee will have a round sum of £20,000 to hand over in relief of the city rates; £10,000 being placed to reserve, renewals, and depreciation account. The net profits are expected to increase considerably during the next few years, a fact which the heavily-taxed ratepayers regard with no small satisfaction. The gross weekly earnings of the lines already opened average about £5,500. The extension to the southern suburbs, including Withington, is being rapidly pushed forward, and the lines will be opened there probably before the end of the year.

Trouble is brewing between the drivers and guards of the Corporation tramways and their employers. The men had a midnight meeting on Saturday last, presided over by Councillor Tostal, of Bolton (the president of the Tramways Employés' Amalgamated Society), and, after a three hours' discussion of grievances, they appointed a deputation to wait upon the Tramways Committee at its next meeting. Two alternative schemes "for relieving the situation" are to be submitted to the Committee. As the meeting was private, it is not known precisely what these are, but it is understood that what the men want is a continuous working day of fixed length, in place of the present broken one.

The Manchester Tramways Committee is seeking to have introduced into the General Powers Bill of the Corporation in the next session of Parliament a proposal to amend Section 9 of the Local Tramways Act of 1899, and Section 22 of the Act of 1900 "so as to provide that the powers of the last-named section as to laying down double or interlacing lines in place of single lines, and *vice versâ*, and as to altering the positions of tramways and other matters, shall extend to tramways outside the city, which are or shall be leased to the Corporation."

The Manchester and Salford Corporations have not as yet found a *modus vivendi* with regard to the vexed question of an interchange of tramway traffic. A sub-committee has been appointed by each authority, and they were to have had a conference last week, but some hitch prevented it. A divergence of views on some minor details seems to stand in the way of any immediate settlement. Meanwhile the public is intensely dissatisfied with the existing state of things.

Oldham.—It is expected that the B. of T. inspector, Major Druitt, will make his official inspection to-day of the new electrical tramway route to Moorside, a section which, when open to the public, will be greatly appreciated by football enthusiasts, as it passes the Oldham F.C.'s ground. The Hensbaw Street to Chadderton section is also about ready.

Rawdon.—The District Council has passed a resolution approving of the scheme of tramways from the Leeds City boundary to Guiseley, which Messrs. Le Maitre & Parker, a Leeds firm of engineers, are preparing on behalf of clients.

Sheerness.—It is expected that in the next few months the electric trams will be in active operation at Sheerness-on-Sea. The work of constructing the permanent way, trolley poles, &c., is progressing rapidly, as well as the building of the generating station, &c. The trolley work will be slightly different to that in use by the Chatham and District Light Railways Company. The contractors are Messrs. J. G. White & Co., of London. The power station will supply energy for both lighting and traction.

South Lancashire.—On Thursday last week Major Pringle and Mr. A. P. Trotter, acting for the B. of T., inspected a newly completed length of 16 miles of track, lying between Lowton, Leigh, Atherton and Tyldesley. Another four miles of track, extending towards Hindley, are nearly complete, so that since the work of constructing the South Lancashire Tramway began, in March last, 20 miles of track have been constructed. The scheme, in its entirety, contemplates the construction of 105 miles of tramways which will connect Liverpool, St. Helens, Wigan, Leigh, Bolton, Atherton, Hindley, Tyldesley, Haydock, Earlestown, Neaton, Golborne, Warrington, Westhoughton, Ince, Ashton-in-Makerfield, Walkden, Worsley, Accrington, Rochdale, Bolton, Manchester, and other towns. Power will be supplied from a central generating station at Howe Bridge, Atherton. The work of construction was begun by Mr. Alfred H. Gibbings, and is now being carried out under the direction of Mr. J. R. Salter, engineer-in-chief. The consulting engineers for this extensive scheme are Messrs. Kincaid, Waller & Manville, London.

Southampton.—The T.C. has applied for a loan of £7,000 for the purchase of 12 additional tram cars.

Stone (Kent).—The Parish Council is considering a proposal from the Electric Tramway Company for extending the service from Gravesend and Swanscombe to Stone.

Stourbridge.—The Dudley, Stourbridge and District Electric Traction Co. has informed the U.D.C. that, owing to the restrictions imposed by the Council on the traffic through High Street, Stourbridge, they cannot see their way to run through cars between Stourbridge and Kingswinford.

Swansea.—The Tramways Sub-Committee was engaged on Wednesday last week in considering several surface-contact systems for the new extension lines. The British Schuckert Electric Traction Company laid an illustrative model installation in the Council chamber. Representatives of other systems, including the Kingsland, were also present.

Tramways v. Railways.—Tube and electric tramway competition between such places as Richmond, Kew, and Acton and the City has compelled the North London Railway to revise its season ticket rates between these points and the City."—*Financial News.*

Tyneside.—The new system of the Tyneside Tramways Company from Gosforth to North Shields was opened on Monday by Mrs. W. A. Watson-Armstrong, wife of the chairman of the company.

Wigan.—A Liverpool paper says that at a meeting of the Electric Light and Tramways Committee last Thursday, it was decided that owing to the loss sustained by the running of the Frog Lane tramway, that route should be closed after October 1st.

TELEGRAPH AND TELEPHONE NOTES

Chilian Cable. — *Commercial Intelligence* says that tenders were recently submitted to the Chilian Government for the construction of a submarine cable between Talcahuano and Puenta Arenas, but as the committee appointed to consider the offers did not recommend any one of them for acceptance, the Government has determined to get fresh soundings made, with the object of issuing another call for tenders.

Wireless Telegraphy.—The *Evening Standard* correspondent at Paris says that the Minister of the Colonies, owing to the frequent interruptions of the submarine cable between Martinique and Guadeloupe by volcanic disturbances, intends to establish communication between the two Islands by means of wireless telegraphy. Capt. Ferrie, of the Engineers, and M. Magne are leaving for the Island with the necessary apparatus. These gentlemen will also instal means of communication between the posts which M. Lacroix will erect in various parts of the danger zone and places in the Island outside the evacuated region which it may seem necessary to warn of the first dangerous symptoms of the volcano.

It is stated that the International Conference on wireless telegraphy will take place shortly in Berlin.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899 ..	..
Communication with Carthagena and Barranquilla (Columbia)	Dec. 8, 1900 ..	..
Trinidad-Demerara No. 1	Aug. 27, 1901 ..	..
Communication with Bolama	April 18, 1902 ..	..
St. Lucia-Grenada	May 8, 1902 ..	..
Dominica-Martinique	May 8, 1902 ..	..
St. Lucia-Martinique	May 8, 1902 ..	..
Guadeloupe-Martinique	May 9, 1902 ..	..
Santa Cruz de Teneriffe to Tejita de Teneriffe	July 4, 1902 ..	..
Puerto Plata-Martinique	July 10, 1902 ..	..
Guantanamo-Mole St. Nicholas	Aug. 5, 1902 ..	..
Cayenne-Pinheiro	Aug. 13, 1902 ..	..
St. Lucia-St. Vincent	Sept. 18, 1902 ..	..
Landlines :—		
Route *via* Hanekin on Persian territory	Feb. 24, 1900 ..	..
Communication with Tientsin and Taku *via* Helampo	July 18, 1900 ..	..

CONTRACTS OPEN AND CLOSED.

OPEN.

Barrow-in-Furness.—October 15th. Two batteries of accumulators, two boosters, switchboards, &c. See "Official Notices" September 26th.

Batley.—October 10th. 240 accumulator cells and accessories. See "Official Notices" September 26th.

Belfast.—October 10th. Electric motors (12 months' supply) for the Corporation. See "Official Notices" Sept. 19th.

Belgium.—October 8th. The Belgian State Railway authorities at La Bourse, Brussels, are inviting tenders for the supply of 109½ tons of galvanised iron telegraph wire, 1,800 metres of office cable, 2,000 metres of six-conductor submarine cable, 606 kilometres of copper wire, 33,000 telephone insulators, and 58,000 telegraph insulators, &c., for the telegraph service.

Dartford.—October 7th. Installation for the Dartford Co-operative Society. See "Official Notices" to-day.

Dudley.—October 18th. Arc lamp carbons. See "Official Notices" to-day.

France.—October 6th. Tenders are being invited until October 6th by the French Post and Telegraph authorities in Paris, for the supply and laying of a submarine cable between Maurice and La Reunion, one between Tamatave and La Reunion, one between Saigon and Pontianak, and one between Brest and Dakar. Particulars may be obtained from, and tenders are to be sent to, Le Sous-Secretariat d'Etat des Postes et Telegraphes, 103, Rue de Grenelle, Paris.

G.W.Ry.—October 16th. Telegraph instruments and apparatus, electric lamps, carbons and other stores for the G.W.Ry. See "Official Notices" to-day.

Ilford.—October 6th. Dry-back boiler, piping and condensing plant for electricity works extensions. See "Official Notices" September 19th.

Ipswich. — October 22nd. (*a*) Switchboard, motor boosters, and connections. (*b*) Overhead construction for tramways. See "Official Notices" September 26th.

Maidenhead.—October 6th. Installation for the Guildhall. See "Official Notices" September 19th.

Manchester.—October 4th. Steel tramway poles. See "Official Notices" September 26th.

Middlesex.—October 7th. The Light Railways Committee of the Middlesex County Council invites tenders for the construction of permanent way (for electric traction), bridge work, &c., of about 11 miles of light railways. The conditions, specification, &c., may be seen at the offices of H. T. Wakelam, M.I.C.E., county engineer, Middlesex Guildhall, Westminster.

London.—October 21st. Two electric car traversers for the L.C.C. tram depôts. Specifications, &c., at Spring Gardens, £2.

N.E. Railway.—October 7th. The directors are inviting tenders for the complete electrification of about 37 miles of standard gauge line (double track mostly). For further particulars see our "Official Notices" July 25th.

Paris.—October 27th. Competition for supply and installation of motors, pumps and generators for water-works. —Apply Hotel de Ville, Paris.

Rotherham.—October 16th. (*a*) Pipes, feed pump, economiser, &c.; (*b*) switchboard. See "Official Notices" September 26th.

Shanghai.—October 30th. (*a*) Two 500-KW. steam alternators; (*b*) switchboards; (*c*) two condensers and pumps. See "Official Notices" September 12th.

St. Petersburg.—November 1st (14th). The T.C. invites tenders for the reconstruction of the three town tramway lines, hitherto worked by horse traction, with electrical power, and the construction of an electric station. The terms of the tender, also application forms with particulars, will be sent free at once either by post or wire. The last date for the production of projects and offers is as above, and applications should be addressed: Stadt Amt, St. Petersburg, Russia.

Stalybridge.—October 13th. The Stalybridge, Hyde and Dukinfield Electricity Board invites tenders for Lancashire boilers, economisers, condenser and pumps, piping, crane, &c. See "Official Notices" September 19th.

Sunderland. — The Electricity Committee of the Sunderland Corporation have authorised their electrical engineer to advertise for tenders for the first instalment of the three-phase plant detailed in the report on the supply of electrical energy to the Docks, and published by us on the 19th ult.

Swindon.—October 4th. Section A.—Station lighting, and motor wiring; Section B.—Testing instruments and accessories. See "Official Notices" September 19th.

Swindon.—October 7th. Installations for consumers' premises for the T.C. See "Official Notices" September 19th.

Tien-Tsin. — November 30th. The Municipal Secretary at Tien-Tsin is calling for proposals for the lighting of the British concessions by electricity. See this column for August 15th.

Watford.—October 14th. Installation for Beech Grove Chapel. See "Official Notices" to-day.

West Ham. — October 7th. Forty-six lighting and traction poles. See "Official Notices" September 19th.

Wigan.—October 20th. (*a*) Electrical equipment of a short length of new tramway and a portion of the existing line; (*b*) construction of same; (*c*) 18 bogie cars, double-deck, four motor. See "Official Notices" September 26th.

CLOSED.

Devon.—The County Council has accepted the tender of the Northern Electric Company, Limited, for installing the electric light at the County Lunatic Asylum, at £1,065 18s. 11d.

Hampstead.—The Borough Council has accepted the tender of Messrs. Rowland Carr & Co., for the supply and delivery of 28 arc lamp columns and brackets.

Newport (Mon.)—Messrs. Alger & Son, Newport, have been entrusted with several important electric light contracts including the lighting of the new Celluloid Works, Port-Talbot, the splendid new works of Messrs. Guest, Keen & Co. (arc and incandescent light being used in this case); and the Redbrook Tinplate Works.

Southampton.—At the last meeting of the T.C. the Tramways Committee submitted the following tenders for the construction of the tramways in Onslow Road, Bevois Valley, and Bevois Hill:—Coston & Co., Ltd., £2,283; F. Osman, £2,288; Douglas & Richards, £2,360; F. Grace, £2,571; W. L. Meredith and Co., Ltd., Gloucester, £2,821 12s. 9d.; Peter Smith, London; £3,040 14s.; M. A. Shepstone, & Co., London, £3,317 11s. 11d. The borough engineer's protecting estimate was £2,813. The Committee recommended the acceptance of Messrs. Coston & Co.'s tender. After discussion, the Committee's recommendation was adopted. The Committee reported that they had considered the tenders for the supply of materials for the proposed new route of tramways and recommended that poles be obtained from the British Thomson-Houston Company, at £5 17s. 6d. each, the same as previously supplied; that the tender of Messrs. Blackwell & Co. be accepted for the supply of bases at £1 each, and that of Messrs. Macartney, McElroy & Co., for scroll work, at 14s. per cwt. The recommendation was adopted.

Stockton-on-Tees.—The Triumph Stoker, Limited, has secured the contract for the mechanical stokers, &c., for five boilers at the electricity works extension.

FORTHCOMING EVENTS.

Friday, October 10th.—At 8 p.m., at Holborn Restaurant. Electro-Harmonic Society's first Smoking Concert for the new session.

Monday, October 13th.—Institute of Marine Engineers. "Standardising of Pipe Flanges and Flanged Fittings," by Mr. J. R. Ruthven.

OBITUARY.

We hear with profound regret of the death of Mr. Fred. Bathurst, A.I.E.E., which occurred quite unexpectedly last Saturday afternoon while he was sleeping. The cause was heart failure following an attack of asthma, to which he had been subject for a number of years. He was a man of remarkable push and energy and indomitable perseverance, as all who have come into touch with him in connection with electric conduit wiring will have recognised from the first moment of meeting him. In fact, his pushfulness and commercial ability in introducing his electric conduit systems seem to have exceeded his physical strength to bear the strain which has to be met in these days of strenuous competition. As our readers are aware, he had only a few months ago completed arrangements for introducing his new "Armorduct" system into this country.

Mr. Bathurst commenced his career as a pupil at the Finsbury Technical College, under Prof. Ayrton, and thereafter he held an appointment with Messrs. Woodhouse & Rawson for several years. Subsequently he visited the United States, and obtained a position of importance at the Edison works, his department being more particularly connected with Mr. Edison himself and his laboratory experiments. It was when he returned from this stay in the States that he first brought back the agency for the interior conduit system of wiring. It may be mentioned that some years ago Mr. Bathurst was awarded the Society of Arts gold medal and a £25 premium for a paper on "Prevention of Fire Risks."

There will be many men in the electrical fraternity who will miss the deceased gentleman, whose energetic ways and straightforward dealings had earned for him their admiration. In the editorial rooms of the Electrical Review, where he was an occasional caller, generally in the capacity of an esteemed contributor, we shall deeply feel his loss, and we would tender to his sorrowing widow our most sincere condolences in the loss of her husband at an age (36) when most men are just beginning to make their mark in life.

The death is also announced of Mr. Alexander Sinclair Macpherson, a principal in the firm of Messrs. Fairbairn, Lawson, Coombe, Barbour, Limited, engineers, of Leeds.

NOTES.

Ourselves. — Our readers may be interested to learn that our "Electric Power" issue met with a most gratifying reception among electrical engineers all over the country. It was also favourably noticed in quite a number of London and provincial newspapers, our specially prepared map of electric power areas calling forth considerable comment. Notwithstanding the extra printing number, we learn from the Publishing Department that the edition has only just met the demand, very few copies being now obtainable. It may, perhaps, be interesting if we mention that the total weight of paper used in the production of that issue was over 5½ tons, and this very large quantity had to be dealt with, sheet by sheet, between the hours of 9 p.m. on Thursday, September 11th, and 3 o'clock the following morning—six hours in all. Opinions which have reached us from many appreciative electrical manufacturing and professional men prove that the issue was, and is, valued as a timely treatise on the progress of electric power.

The Electric Post.—A correspondent writing under date Paris, September 27th, 1902, says:—"On inquiry at the office of the Under Secretary of State for Posts and Telegraphs, I was informed that the French authorities are taking a keen interest in the proposal of the Italian engineer, Piscicelli, to employ aerial lines for the transport of correspondence. So far as the experts can judge from the meagre descriptions which have been telegraphed, the system seems to promise success. The French authorities have, it appears, been conducting a series of experiments for the electrical transport of letters between the Chief Post Office in the Rue du Louvre and the Northern Railway Terminus, a distance of about two miles. Underground conduits were used, and although the problem of rapid transport was easily solved, the difficulties in the way of dealing with a large mass of correspondence caused the abandonment of the experiments. The mail cart system has now been again requisitioned, but the experiments may be resumed. The officials are of opinion that the estimated cost of the Piscicelli system, 3,000 francs per kilometre is very low, and they are looking hopefully to it to solve some of their unsolved problems in rapid postage."

"Electro-chemical Industry."—We have received from the Electro-chemical Publishing Company, of Philadelphia, a copy of the first issue of this new journal. It carries with it a businesslike impression, and has a number of well-illustrated articles on electro-chemical subjects, the *pièce de resistance* being a full account of the electro-chemical industries carried on at the Niagara Falls, written by Mr. J. W. Richards, Ph.D., president of the American Electro-chemical Society. Other contributions are "Transformers for Electro-chemical Work," by J. S. Peck; "Electro-chemistry as an Engineering Course," by Prof. C. F. Burgess; "Pioneers of Electro-chemistry"; "Electro-chemical Theories Illustrated by Examples from Practice"; analysis of electro-chemical patents; and a synopsis of articles in other journals. We extract the following list of papers which were to come before the September 15th to 18th second general meeting of the American Electro-chemical Society at Niagara Falls:—

Francis A. J. Fitzgerald, Niagara Falls, N.Y.: "Note on Testing Carbon Electrodes."
Prof. J. W. Richards, Ph.D., Lehigh University, Bethlehem, Pa.: "Efficiency of Electric Furnace Operations."
P. G. Salom, Philadelphia, Pa.: "Additional Notes on Lead Reduction."
Alfred T. Weightman, Niagara Falls, N.Y.: "Cathodic Reduction."
Prof. Louis Kahlenberg, Ph.D., University of Wisconsin, Madison, Wis.: "Differences of Potential between Metallic Cadmium and Solutions of Cadmium Iodide in Various Solvents."
Prof. R. S. Hutton, Owens College, Manchester, England: "The Fusion of Quartz in the Electric Furnace."
Marcus Ruthenberg, Philadelphia, Pa.: "Developments in Electrometallurgy of Iron and Steel."
Prof. H. T. Barnes, Ph.D., McGill University, Montreal, Can.: "Theory and Practice of Continuous Flow Calorimetry."
Carl Hering, Philadelphia, Pa.: "An Apparent Electro-chemical Paradox."
C. J. Reed, Philadelphia, Pa.: "Some Phenomena of Electrolytic Conduction."
Prof. Henry S. Carhart, LL.D., University of Michigan, Ann Arbor, Mich.: "The Nickel Concentration Cell."
Prof. W. E. Goldsborough, Lafayette, Ind.: "Electro-chemistry at the World's Fair, St. Louis."
Arvid Reuterdahl, Providence, R. I.: "The Electronic Hypothesis and Its Applications."
Prof. John Langley, Ph.D., Cleveland, Ohio: "Electro-chemical Polarisation."
Hugh Rodman, Philadelphia, Pa.: "Storage Battery Invention."
Woolsey McA. Johnson, New Brighton, S.I., N.Y.: "The Electrolytic Dissolution of Soluble Metallic Anodes."
C. W. Volney, Ph.D., Keyport, N.Y.: "On the Electrolysis of Sodium Nitrate and the Composition of the Developed Gases."
D. H. Browne, Cleveland, Ohio: "Pumps and other Accessories in Electrolytic Plants."
Prof. G. B. Frankforter, University of Minnesota, Minneapolis, Minn.
Titus Ulke, Sault Ste. Marie, Ont., Can.
Alfred H. Cowles, Cleveland, Ohio: "A Unit of Quantity of Electricity for Use in Electro-chemical Calculations."
Edw. R. Taylor, Penn Yan, N.Y.: "Some Further Advances on the Closed and Continuous-Working Electric Furnace."
Prof. F. Haber, Ph.D., Karlsruhe, Germany.

We wish our new American contemporary every success. No doubt there is more scope for such a journal in the States than there is in this country at the moment.

National Physical Laboratory.—The Committee of the Laboratory has issued a set of pamphlets detailing the tests in the Physics, Engineering and Observatory Departments which it is now prepared to carry out. The director, Dr. Glazebrook, points out that the two first-mentioned are at present in many respects provisional; the Committee desires to develop the work in the directions indicated by the demands received for assistance, and is willing to consider suggestions for the extension of the work and the modification of details.

The Observatory Department is, of course, the most advanced, as the work done there in connection with barometers and pressure gauges, thermometers, ships' instruments, watches and meteorological apparatus has been carried on for many years.

The Physics Department is ready to deal with electrical instruments of all kinds, insulation resistance of cables and insulators, arc lamp carbons, standard and other cells, magnetic properties of materials, D.C. motors, arc lamps, &c., and with high-range and low-range thermometers, line and end measures, measuring glasses and weights. Photo-micrographic examination of metals (especially steel rails), and the testing of lenses, are also carried on in this Department.

The Engineering Department, which is situated with the last-named at Bushy House, is equipped for testing pressure and vacuum gauges, indicators, workshop gauges, and materials of construction; the apparatus is as yet incomplete, the nature of the equipment to be provided being dependent largely upon experience of the demand.

The importance of the work done and to be done by the Laboratory has been amply emphasised in our columns. We trust that full advantage will be taken of the facilities offered to manufacturers for the performance of accurate and impartial tests. The fees scheduled in the pamphlets before us are in most cases trifling, compared with the increase in value of the instruments tested when accompanied by a certificate of accuracy, and no doubt it will be found far more economical and satisfactory to have certain kinds of measurements made by experts, with costly apparatus permanently set up, than to attempt to carry them out under the conditions obtaining in a manufacturing establishment.

"A House Divided Against Itself," &c.—Last week we quoted a small instance of trade union practices in the electric wiring business in Chicago. As we wrote the scene was shifting to this side of the Atlantic, for the Bradford Tramway Committee has had to face a similar difficulty. The joiners and coach builders of that city have been disputing as to which of them are entitled to carry out repairs to car bodies, and deputations have attended before the Committee to argue the matter. The Committee, however, proved unequal to understanding the distinctions laid down, and asked the men to settle the matter themselves as between their two unions.

What Price This?—A German engineer, who has been identified with some of the largest electrical accomplishments in Germany, a few days ago remarked, at the luncheon table of a Cincinnati hotel:—"Before I left Germany I wrote four of our largest electrical machinery manufacturers, advising that I was about to instal a generator of large units, and would like their prices for the machine. From three of the four leading manufacturers addressed I received replies, which asked, 'What will you give?' The fact is, the shops of the German electrical manufacturers are almost idle, and they will accept orders at any figures offered."—New York *Electrical Review*.

Personal.—Mr. Michael B. Field, at present electrical engineer to the Glasgow Tramways, has been appointed to the position of contract engineer by Messrs. Ferranti, Ltd., Hollinwood. Mr. F. Barnes Spencer, at present engineer to the Wimbledon Urban District Council, has been appointed to the position of sales manager by the same company. These gentlemen will jointly represent Messrs. Ferranti, Ltd., and their headquarters will be in London, where an office is shortly to be opened.

Mr. J. Kerrigan, manager of the Dewsbury, Batley and Birstall tramways, has been appointed to a managership at Peterborough, and Mr. Lionel Johnston, of Middleton (Lancashire), has been appointed manager of the Dewsbury, Batley and Birstall tramways.

Mr. Morton Beales, formerly of Messrs. Ferranti, Ltd., and latterly commercial engineer to Messrs. J. G. White & Co., has resigned his position with that firm in order to accept a post on the staff of the British Westinghouse Electrical and Manufacturing Co., Ltd. His new duties commenced on September 15th.

The Glasgow Engines.—We are pleased to note that our esteemed contemporary, the *Engineer*, adopts the same attitude as ourselves with regard to the tests recently made on the Pinkston engines. In a leading article on this subject, our contemporary remarks that "the inner history of the contract will probably never be written"—an opinion with which we are quite in accord. Pointing out, as we did on August 29th, that Prof. Barr's report, which was understood to be private, was commented on and misquoted in the columns of a contemporary while "the ink was hardly dry," "exalting the American engines at the expense of those made in England and Scotland," the *Engineer* explains that it received no copy of the report at all, and is obliged to quote a monthly journal.

Our contemporary severely criticises the report, commenting especially on the points which we have already emphasised, and remarks that "the danger lies in regarding the report as holding the reputation of a really scientific document." The result appears to the *Engineer*, as it does to us, to be "next to incredible."

We have said enough about the tests; they relate solely to the engines. The performance of the alternators has not been reported upon, so far as we are aware, but we know the quality of the B.T.H. generators well enough to feel sure that they are satisfactory. A steam alternator, however, has characteristics of its own, entirely apart from the special features proper to its component parts, and one of the most important of these is the ability to run in parallel with others—or the lack of it. We know that provision is made on the switchboard for running the generators either in parallel or separately, at will; and we should appreciate, as would our readers, an official statement as to the practice followed at Pinkston. Can these steam alternators be run in parallel in regular working; and are they regularly run in parallel?

Finsbury Lectures and Courses.—The evening courses in electrical engineering at the Technical College, Finsbury, begin on Monday, October 6th. In the Advanced (Monday night) course, Prof. Silvanus Thompson will lecture on "Three-phase," and later on "Dynamo Design." Mr. Simmons will take part of the lectures after Christmas. On the Wednesday evenings Mr. Darling will lecture on "Electrical Instruments, &c.," and later Prof. Thompson will take up "Magnetism and Electro-magnetic Apparatus." On Friday nights, commencing October 10th, Mr. Darling and Prof. Thompson will share the lectures on "Physics," Prof. Thompson giving those on "Light," and Mr. Darling those on "Heat," including "Thermodynamics."

Liverpool Overhead Railway.—On Wednesday the accelerated service on the Liverpool Overhead Railway began. The new equipment has already been described in our columns.

German Losses.—The balance-sheet of the Electricitäts-Gesellschaft Felix Singer & Co., of Ehrenfeld, Cologne, for the financial year 1901-2 shows a loss of £16,617. The Rheinau Mannheim Chemical Industry Joint Stock Co. is now shown to have worked at a loss for many years, but deficits had been concealed by means of false entries, for which directors have just been arrested. The capital of 2½ million marks is said to have been practically lost. It is stated that failures of other firms connected with the Society of Chemical Industry are feared.

Electricity Supply.—The L.G.B. has informed the Barking U.D.C. that the deficit of £2,300 on the electric lighting revenue account must be paid out of the next rate, instead of spreading it over several rates. Since our leader pages went to press, we have made a further examination of the Board of Trade returns, and find that the municipal losses column total comes out at £151,000, the figure of £102,900 being obtained after the surplus total had been deducted therefrom. We were misled by the compiler's curious way of bringing down his total, which at first sight makes it look as though there were surpluses in no cases, but losses in all.

Electro-Harmonic Society.—On Friday evening next, October 10th, the first concert of the 1902—3 season will take place in the Crown Room of the Holborn Restaurant. The change of place is due to the rebuilding operations which are now in progress at the St. James's Hall. It is hoped that there will be a large gathering to give the Society a good "send-off" for the season.

Electrical Laboratory at Stratford Mechanics' Institute.—On Tuesday evening last week Lord Claud Hamilton opened the new electrical laboratory at the G.E. Railway Mechanics' Institute at Stratford.

Appointments Vacant.—An electrical engineer for the Glasgow Corporation Tramways (£500); assistant lecturer and senior demonstrator in electrical engineering for the Royal Technical Institute at Salford, at £130; junior assistant engineer for the Watford electricity works; chief assistant electrical engineer for West Bromwich. See "Official Notices" to-day.

THE CENTRAL STATION ENGINEER.

Mr. J. C. Robertson, engineer-in-charge at Perth electricity works, has been appointed assistant-in-charge at Dewar Place Works, Edinburgh.

Mr. J. Keenan, charge engineer, on leaving the Bedford electricity works for a post at Taunton electric light station was presented with a silver-mounted pipe and tobacco.

Mr. J. A. Beattie, of the Brighton electricity works, was presented with a set of Sheffield cutlery on the occasion of his marriage. Mr. Christie made the presentation.

A proposal was to be submitted at the meeting of the Oldham T.C. on Wednesday, to raise the salary of the electrical engineer, Mr. S. W. Newington, from £275 to £325 per annum.

Mr. F. Barnes Spencer is relinquishing the post of chief electrical engineer to the Wimbledon Council, as he has secured a better appointment (see "Notes"). Mr. Lee who has been chief assistant at the station under Mr. Spencer, has been promoted to take that gentleman's place.

On Wednesday last week, the officials and staff of the Harrogate Corporation Electricity Department met at the electricity works for the purpose of presenting to Mr. Geo. Wilkinson, M.I.E.E, M.I.M.E., borough electrical engineer, a handsome clock suitably inscribed, on the occasion of his marriage. Mr. Neil McLean, chief assistant engineer, in making the presentation, referred to Mr. Wilkinson's capabilities, and said that it was mainly due to Mr. Wilkinson's management and goodwill that the undertaking had grown to the extent which it had done; and he had no doubt that in the future, if the same mutual good feelings existed between Mr. Wilkinson and his staff, the place would grow with the same rapidity as hitherto; the present record of 1½ lamps per head of population was "one which could not be beaten." Mr. McCourt, mains engineer to the department, followed in a similar strain, and Mr. Wilkinson having suitably responded, three hearty cheers for him, and three more for the future Mrs. Wilkinson, brought the proceedings to a close.

Mr. G. R. Spurr, assistant electrical engineer at the Ilford electricity works, was married on 24th ult. to Miss Nash, at St. Mary's Church, Stamford Brook.

Mr. J. G. Griffin, chief assistant electrical engineer at Burnley, who has accepted the appointment of borough electrical engineer and tramways manager at Swindon, was presented with a tantalus by his Burnley friends on September 26th. Mr. Griffin was married on October 1st.

Bristol Corporation Electrical Committee has appointed Mr. Crowther, of Leeds, as assistant mains engineer, in succession to Mr. Morgan, who has been promoted.

Mr. Norman E. G. Little, late of Bolton Corporation electricity works, has been appointed chief assistant electrical engineer for the Doncaster Corporation.

The Fulham Borough Council has appointed Mr. F. P. Fletcher, of Canterbury, as engineer-in-charge at the Fulham electric lighting station, in the place of Mr. E. Perry, who has recently resigned.

NEW COMPANY REGISTERED.

Atmospheric Electrical Purification Co., Ltd. (74,926).—This company was registered on September 23rd, with a capital of £16,000 in £1 shares (12,500 ordinary and 3,500 deferred), to acquire a license to manufacture, sell and use, exclusively in Lancashire, all apparatus necessary to carry into effect Patent No. 17,805 of 1901, for improvements in the purification of air, to adopt an agreement with Col. J. Harris of the one part and S. C. Ede of the other part, and to carry on the business of an electrical company and of purifiers of air in all its branches. The first subscribers (each with one share) are:—H. Hutchinson, Broomefield, Old Trafford, engineer; M. T. Barber, 14, Cumberland Street, Manchester, printer; J. Boydell, Ashby Road, Hale, Ches., merchant tailor; J. S. Pixton, 29, Brown Street, Manchester; A. D. Pixton, 29, Brown Street, Manchester, stockbroker; J. E. Ramsdale, 8, York Street, Manchester, accountant; and W. H. Hastings, 54, Deansgate, Manchester, insurance manager. Minimum cash subscription, £2,000; the number of directors is not to be less than three nor more than five; the first are Col. J. Harris, and others to be appointed by the subscribers. Registered office, 21, Spring Gardens, Manchester.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Thomas Parker, Ltd., (40,973).—This company's annual return was filed on July 19th, when the entire capital of £75,000 in 7,500 shares of £10 each had been taken up; £10 has been called up on 3,750, resulting in the receipt of £37,500; 1,750 shares are considered as fully paid. Mortgages and charges, £58,700. (Note—£300 debentures subsequently issued.)

Particulars of mortgages and charges. This company issued, on July 29th, £300 debentures, part of a series created June 23rd, 1898, to secure a total sum of £75,000. Property charged: the company's undertaking and property, present and future. There are no trustees. Total amount previously issued of same series, £58,700.

Tyer & Co., Ltd. (56,760).—This company's annual return was filed on June 20th, when 22,007 shares were taken up out of a nominal capital of £35,000 in 35,000 shares of £1 each. £1 per share has been called up on 2,007 shares, resulting in the receipt of £2,000. £7 remains in arrears. £20,000 is considered as paid. Mortgages and charges—*nil*.

Sunbeam Lamp Co., Ltd. (25,498).—This company's annual return was filed on September 18th, when 1,765 shares were taken up out of a nominal capital of £25,000 in 2,500 shares of £10 each. £10 per share has been called up on 903 shares, resulting in the receipt of £9,030. 857 shares are considered as fully paid. Mortgages and charges—£5,150.

Column Printing Telegraph Syndicate, Ltd. (29,493).—This company's annual return was filed on August 21st, when 289 shares were taken up out of a nominal capital of £25,000 in 500 shares of £50 each; £50 per share has been called up on 189 shares, resulting in the receipt of £9,006 5s. £443 15s. remains in arrears. £5,000 is considered as paid on 100 shares. Mortgages and charges, *nil*.

Crompton & Co., Ltd. (27,200).—This company's annual return was filed on August 27th, when 85,000 shares were taken up out of a nominal capital of £300,000 in 100,000 shares of £3 each. £3 per share has been called up on 83,000 shares, resulting in the receipt of £249,000. £6,000 is considered as paid on 2,000 shares. Mortgages and charges, £100,000.

Exchange Telegraph Co., Ltd. (6,152).—This company's annual return was filed on August 16th, when 8,098 "A" and 16,200 "B" shares were taken up out of a nominal capital of £246,250 in 8,125 "A" and 16,500 "B" shares of £10 each. £9 has been called up on each of 6,000 "A" and £1 on each of 2,023 "A" shares, resulting in the receipt of £56,023. £172,000 is considered as paid, being £10 per share on 16,200 "B" and £8 per share on 2,125 "A." Mortgages and charges, *nil*.

CITY NOTES.

Chloride Electrical Storage Co., Ltd.

Dr. Edward Hopkinson presided at the annual meeting held at Clifton Junction on September 16th. He regretted exceedingly to inform them of Dr. Bowman's resignation from the chairmanship and board of the company since the report was issued. Dr. Bowman had held the office of chairman for some six years. The board had elected Mr. William Bannister, J.P., of Cork, as chairman. He had been a director for some six years.

Mr. Bannister then took the chair.

The secretary having read the notice of the meeting and the auditors' certificate, the Chairman proceeded to read the report, and said, with reference to the balance-sheet, that as a shareholder he considered the figures to be eminently satisfactory in every way. He added that the company had never been since its inception in so strong a position, both in regard to the quality of the work done and the way in which it was turned out. Testimonials from experts in the position to express an opinion of the quality of storage batteries were being received, and were in every way satisfactory. The company had now acquired such a high position, technically and financially, that although up to the present the shares had been unsaleable, there was now quite an inquiry for them. He himself had been asked to sell a number of his shares at par, but he did not feel inclined to do so. He considered the company was now in such a position that the shareholders might look forward to receiving a satisfactory return on their holdings. He hoped and anticipated that there were good times now in store, after the long period of depression through which the company had passed.

The adoption of the report was seconded by Mr. Harvey, and carried unanimously.

A resolution declaring a dividend at the rate of 6 per cent. per annum on the preference shares, less income-tax, and 8 per cent. on the ordinary shares, free of income-tax, from April 14th, the date of the reduction of capital, to June 30th, the end of the financial year, was carried unanimously. Mr. Bannister, the retiring director, was re-elected, as were also the auditors, Messrs. Parkinson, Mather and Co.

The meeting subsequently passed a resolution expressing their regret that circumstances have compelled Dr. Bowman to resign his position as chairman of the company, and recording their appreciation of his services rendered to the company during the last six years.

City of Buenos Ayres Tramways Co.

The report for the half-year ended June 30th last states that the directors have now received the report from Dr. Kennedy, based upon the calculations which have been made out by the expert who has been out in Buenos Ayres for some months with a view to investigating as to whether the system should be converted to electric traction. The report of Dr. Kennedy is strongly in favour of the change. Consultations have taken place between the representative of Dr. Kennedy, the local committee, and the general manager, resulting in a united recommendation that electric traction should be adopted. The local committee has been instructed to

apply for the necessary modification of the concession, subject to the approval of the shareholders; and when the terms upon which such will be granted have been ascertained, the matter will be submitted to a meeting of the company for consideration.

New St. Helens and District Tramways Co.

The third annual meeting of shareholders of the above company was held on Saturday at Liverpool, Mr. J. B. Atherton presiding.

The report for the year, which ended on June 30th, showed an increase in the traffic receipts over the previous year of £4,130, and an increase in the expenditure of £3,608. This last increase was partly due to an increase in the mileage run, but chiefly to the larger sums payable to the Corporation of St. Helens for rent, interest and electric current. In 1900 the amount paid was £15,368, while for the last year the amount was £17,976, an increase of £2,608. The traffic prospects were reported to be encouraging, as larger use was being made of the tramways by the people of St. Helens.

When moving the adoption of the report, the Chairman said that the situation, compared with last year, was certainly very encouraging. Last year there was a credit balance on trading account of £1,080, whereas the profit for the 12 months ending in June last was £1,650. The opening of the Knotty Ash section of the Lancashire Light Railways Company considerably improved the earnings of their own company. Replying to questions, the chairman stated that after prolonged negotiations, the directors had made an arrangement with the St. Helens Corporation as to goods traffic. The report and accounts were adopted.

Mr. H. Martin, J.P., was re-elected a director of the company, and Messrs. Chalmers and Wade were re-appointed auditors.

Anglo-American Telegraph Co. — After placing £5,000 to the credit of the renewal fund, the board is declaring an interim dividend for the quarter ending September 30th, 1902, of 15s. per cent. on the ordinary stock and £1 10s. per cent. on the preferred stock, less income-tax.

Evered & Co., Ltd.—The directors have decided to pay an interim dividend at the rate of 7½ per cent. per annum for the half-year ended June 30th last.

Eastern Telegraph Co.—The directors announce the payment, on October 15th next, of a dividend at the rate of 3½ per cent. per annum on the preference stock for the quarter ending September 30th, and the usual interim dividend of 1¼ per cent. on the ordinary stock, tax free, in respect of profits for the quarter ending June 30th.

Eastern Extension, Australasia and China Telegraph Co.—The directors have declared an interim dividend for the quarter ended June 30th last of 2s. 6d. per share.

Stock Exchange Notice. — The Committee has appointed a special settling day as under:—Wednesday, October 8th, Colombo Electric Tramways and Lighting Co., Ltd.—£120,000 5 per cent. first mortgage debenture stock.

Dick, Kerr & Co.—A meeting of this company was held on Monday at 110, Cannon Street, E.C., but the proceedings were conducted in private.

TRAFFIC RECEIPTS.

Company.	Week ending	Receipts for the week. Am'nt.	Inc. or dec.*	Total to date. Am'nt.	Inc. or dec.*	Miles open. This year.	Last year.
		£	£	£	£		
Blackburn Corp. Trys. ..	Sept. 26	831	+ 50	29,665	+ 3,797	12½	13½
Blackpool and Fleetwood	,, 27	1,013	+ 90	17,431	— 446	7½	7½
Bristol Trys. & Car. Co.	,, 26	4,394	+811	—	—	28	28
British Elec. Trac. Co.:—							
Devonport	,, 19	480	+ 17	16,408	+ 615	5	5
Dudley—Stourbridge..	,, 19	807	+ 56	28,362	+ 3,689	18½	18½
Gateshead	,, 19	870	+249	27,764	+ 4,843	10½	9½
Gravesend	,, 19	205	—	1,558	—	3½	—
Greenock—Pt. Glasgow	,, 19	556	+305	19,080	+11,542	7½	7½
Hartlepool	,, 19	282	— 2	9,788	+ 1,180	6½	4½
Kidderminster	,, 19	136	—	4,769	+ 11	4½	4½
Merthyr	,, 19	198	— 37	7,650	— 1,416	3	3
Middleton	,, 19	268	—	8,061	—	8½	—
Oldham—Ashton ..	,, 19	525	+ 3	20,026	+ 964	8	8
Poole	,, 19	331	+ 21	9,905	— 107	3½	3½
Potteries	,, 19	1,679	+ 64	55,151	+ 2,163	28½	28½
Rothesay..	,, 19	163	+ 51	1,170	+ 350	—	—
Southport	,, 19	296	+119	9,878	+ 3,505	5½	5½
South Staffordshire..	,, 19	691	—165	28,786	— 426	21½	22½
Swansea	,, 19	531	+ 54	17,970	+ 1,172	5½	5½
Taunton	,, 19	68	— 34	2,588	— 198	1½	—
Tynemouth	,, 19	379	+101	11,434	+ 1,359	3½	3½
Weston-super-Mare..	,, 17	199	—	4,817	—	2½	—
Wolverhampton Dist.	,, 19	816	+192	7,287	+ 4,795	10½	22½
Central London Railway	,, 27	6,599	+607	81,966	+ 6,943	6	6
City and S. London Ry.	,, 26	3,026	+1,090	26,244	+12,035	6½	4½
Doncaster Corp. Trys. ..	,, 27	—	—	1,546	—	5½	—
Dover Corporation Trys.	,, 27	253	— 16	6,788	+ 115	3	3
Dublin United Trys. ..	,, 26	4,905	+572	65,774	+ 688	46	46
East Ham Tramways ..	,, 24	588	+145	—	—	5	4½
Glasgow Corp. Trys. ..	,, 27	13,081	—1,196	205,537	—10,128	56	46½
Liverpool Overhead Ry.	,, 28	1,473	—117	20,804	— 1,816	6½	6½
Newcastle Corp. Trys. ..	,, 27	3,007	—	—	—	35	—
Sunderland Corp. Trys.	,, 28	1,180	+ 8	—	—	17½	17½

* Compared with the corresponding period of 1901.

STOCKS AND SHARES.

Wednesday Evening.

No new experience is it for the Stock Exchange to have all its markets upset by reason of financial stringency in New York, but the repetition of the trouble is none the less unpleasant each time. Brought to the very verge of a panic the other day, the American market may be said to practically govern movements in other departments far removed from the immediate sphere of its influence, and the flatness of the funds is partially traceable to the over-financing of Yankee affairs, which has dealt so severe a blow to American speculators on the bull tack. Similarly, the break in the Kaffir Circus has the Yankee collapse as a leading motive, and investment securities have had to be realised in order to meet losses elsewhere. The markets with which this article is connected have so far come out of the ordeal remarkably well, and the few changes which have occurred are mostly of the *ex* dividend order. There is no important fall to be recorded in either electricity or telegraph descriptions.

Home railway stocks have naturally fallen along with Consols, but the only change in electrical rails is a decline of a point in City and South London Ordinary. Central London Preferred may, perhaps, be called a little higher, by reason of the widening upwards of the quotation. City and South London 1901 Preference stock has moved up a trifle to 124, the 1898 and 1891 Preferences are quoted at 127½ and 129½ respectively, while Central London 4 per cent. Debenture stock at 117½ is the same price as the kindred security of the City and South London. It may be remarked that from both these stocks the unusually high rate (as regards Debenture stocks) of £3 8s. per cent. can be obtained on the money invested, whereas London and North-Western or Midland Debentures return but little more than 3 per cent. to the investor. Of course these latter examples possess all the prestige attaching to investments of the strict Trust order, which advantage is not shared by the stocks of the two "Tube" companies.

Traction issues continue in good odour, and Anglo-Argentine trams keep well up at 4⅜ *ex* the recently declared dividend. British Electric Traction Debenture has come to the front, and allowing for deduction of the interest, is 1½ points better. Brisbane Electric Tramways Preference are a pretty good market, about 4¼, and London United Preference continue in the neighbourhood of 12. Potteries Electric Traction are 9, and 10½ for Ordinary and Preference shares, but there is very little doing in either at the moment.

Only one quotable change has to be recorded in the electricity supply market, and that is, a rise of ¼ in Charing Cross and Strand Preference shares. The new Ordinary shares are nominally 8—9, and business was marked the other day at 8¾. A few Primitiva Gas and Electric Lighting of Buenos Ayres Preference have come on offer, and the price is about 4½, the Ordinary being 2½, and the Debenture stock 94. Metropolitans hover around 16, and the delay in announcing the result of the arbitration case is arousing deep disgust. City of London are 9⅝—9¾. The chief dealer in the market is still confined to his room by indisposition, and it is hardly expected that he will be back for a week or two.

Telegraph varieties are very steady, even the Anglo-American group showing no fresh weakness, notwithstanding the slump in Yankee rails. The companies should be doing good business now, for, although there is not much open London account in Americans, the Stock Exchange is following the course of the market with keenest interest, and the cables are unwontedly busy. In the Eastern division, a decline of a point in Eastern Telegraph Debenture has to be noted, and "China" shares are a quarter easier. Small gains have been scored by Western Telegraph Debenture stock and West India and Panama first Preference shares. It is understood that the most recent eruptions in the West Indies have passed almost harmlessly over the telegraph companies. National Telephone second Preference, with a rise of 10s., furnish the only alteration in the telephone section.

Several calls have fallen due this week, and Urban Electrics are now quoted at 4 for Ordinary and Preference, the sovereign rise being the amount called up on Wednesday last. Callender's new Debenture scrip has also 35 per cent. more paid on it. The company's issues are unaltered, and the feature in the miscellaneous market is the strength of British Insulated Wire shares, the Ordinary being 15s. better and the Preference 5s. When the Telegraph Manufacturing Company was absorbed there were a number of B.I.W. fractions distributable to the shareholders, but these were sold in the market and money paid in lieu of fractions. The Stock Exchange lowered the price of the shares in view of the sales of these oddments, and now that the latter are out of the way the shares are allowed to advance. Brush Ordinary and Preference are both ¼ easier. Incidentally it may be mentioned that in the report of that flourishing concern, the Birmingham Small Arms Company, the directors state that the old steam engines which have so far been used in the manufacture of guns, are in a few months' time to be replaced by electric motors.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotation Sept. 24th.	Closing Quotations Oct. 1st.	Business done during week ended Oct. 1st. 1902. Highest.	Lowest.
67,100	African Direct Telegraph, 4 % Debs.	100	...	...	...	98 —102	98 —102	...	...
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	...	...	...	3½— 4½	3½— 4½	...	...
£19,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	70 — 80	70 — 80	...	...
788,840	Anglo-American Telegraph	Stock	73/6	3½%	61s.	47 — 50	47 — 50	48⅛	47½
3,105,580	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	91 — 93	91 — 93	92⅝	91½
3,105,580	Do. do. Deferred	Stock	£1 7s.	5s. %	2s.	7½— 7⅝	7½— 7⅝	7⅞	7 1/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	5 %	5 %	3½— 4	3½— 4	...	...
£2,333,300$	Commercial Cable	$100	8 %	8 %	8 %	160 —170	160 —170 xd	...	...
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	95 — 97	93 — 96 xd	96	94⅝
16,000	Cuba Telegraph	10	7 %	4½%	4 %	5½— 6½	5½— 6½	5⅞	...
6,000	Do. 10 % Pref.	10	...	...	...	13 — 14	13 — 14	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	2½— 3½	2½— 3¼xd	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	7 — 8	7 — 8 xd	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10½— 11	10½— 11	10⅝	...
96,300	Direct West India Cable, 4½ % Reg. Deb., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	124 —129	124 —129	128	125½
1,955,565	Do. 3½ % Pref. Stock	100	...	...	...	90 — 93	90 — 93	93	91
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	108 —111	107 — 110	108½	108
300,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	12½— 12⅝	12 — 12½	12⅝	12½
£20,000£	Do. 4 % Deb. Stock	Stock	...	...	...	107 —110	107 —110	...	...
£80,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	5½%	...	...	99 —102	99 —102	...	...
£20,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—3,000	25	...	...	...	101 —104 %	101 —104%	...	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	5½%	9½— 10	9½— 10	9⅞	9⅝
180,042	Do. do. 6 % Pref.	10	...	...	...	13½— 13⅝	13½— 13⅝	13 11/16	13⅝
150,000	Great Northern Telegraph, of Copenhagen	10	12½ %	15 %	15 %	26 — 27	26 — 27	...	...
70,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	38 — 42	38 — 42	38	...
£60,000£	London Platino-Brasilian Telegraph, 6 % Debs.	100	...	...	...	101 —105	101 —105	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	2½%	...	...	⅛— ¼	⅛— ¼	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	5 %	...	...	¾— 1	¾— 1	...	...
1,983,333	National Telephone, Pref. Stock	100	5 %	5 %	5 %	93 — 95	93 — 95	93	...
1,966,667	Do Def. Stock	100	...	60	64 xd	55 — 57	55 — 57	56½	55
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 13	12 — 13	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 12	11½— 12½	11⅝	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅞— 5⅛	4⅞— 5⅛	4 15/16	4⅞
£2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	96 — 99	96 — 93	97½	...
600,000	Do. 4 % Deb. Stock Red.	100	...	4 %	4 %	102 —106	102 —106	103	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	6 %	6 %	¾— 1	¾— 1	...	...
£100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	5 %	6½— 7	6½— 7	...	...
3,303	Submarine Cables Trust	Cert.	...	...	...	110 —120	110 —120	...	...
58,000	United River Plate Telephone	5	7 %	7 %	7 %	4⅞— 5⅛	4⅞— 5⅛	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4½— 5	4½— 5	...	...
£79,947£	Do. do. 5 % Debs.	Stock	...	...	...	101 —104	101 —104	...	...
15,609	West African Telegraph, Shares	10	...	...	...	3½— 4⅛	3½— 4½	...	...
80,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	⅛— ⅜	⅛— ⅜	...	...
£50,000£	Do. do. 4 % Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	98 —101	98 —101	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	7 %	11⅞— 12¼	11⅞— 12¼	12	11⅞
£75,000£	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	102 —105	102 —105	...	...
400,000	Do. do. 4 % Deb. Stock Red.	100	...	...	...	98 —101	99 —102	...	...
88,321	West India and Panama Telegraph	10	5%	4 %	...	¼— ½	¼ — ½	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	4⅞— 5¼	4½— 5	4⅝	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	3 — 4	3 — 4	...	...
£0,000£	Do. do. do. 4 % Debs., Nos. 1 to 1,800	100	...	...	...	99 —102	99 —102	...	...

ELECTRICITY SUPPLY COMPANIES.

100,000	Blackheath and Greenwich Dist. Electric Light, Ord. ...	1	...	...	...	⅜— ⅝	⅜— ⅝	...	...
100,000	Do. 4½ % 1st Deb. Stock, Prov. Certs.	100	...	...	...	103 —106	103 —106 xd	...	...
20,000	Brompton & Kensington Elec. Lt. Sup., Ord., 1 to 20,000	5	6 %	6 %	8 %	10½— 10⅝	10½— 10⅝	...	...
20,000	Do. do. 7 % Cum. Pref....	5	...	...	...	10½— 10⅝	10½— 10⅝	...	...
50,000	Charing Cross and Strand Electricity Supply	5	9 %	9 %	10 %	9 — 9½	9 — 9½	...	...
70,000	Do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5⅝	5½— 6	5 11/16	...
40,000	Do. do. "City Undertaking" 4½ % Cum. Pref.	5	...	...	...	4⅝— 5½	4⅝— 5½	...	...
£50,000	Do. do. 4% Deb. Stock Red.	100	...	...	...	105 —107	105 —107	...	...
44,436	*Chelsea Electricity Supply, Ord.	5	6 %	5½%	4 %	5½— 5⅝	5½— 5⅝	...	...
£60,000£	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	109 —112	109 —112	...	...
70,595	City of London Electric Lighting, Ord. 40,001—110,595...	10	4 %	0 %	5 %	9 — 10	9 — 10	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12½— 13½	12½— 13½	...	...
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	123 —128	123 —128	...	...
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	...	...	...	103 —106	103 —106	105½	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	4 %	4 %	4 %	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	11½— 12½	11½— 12½	...	...
400,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	111 —114	111 —114	108½	...
50,000	Edmundson's Elec. Corp., Ord. Shares	5	6 %	7 %	7 %	6½— 6⅝	6½— 6⅝	6½	...
30,000	Do. do. 6 % Cum. Pref.	...	...	...	...	6 — 6½	6 — 6½	6 7/16	...
140,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	107 —110	107 —110	108⅛	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	11%	12%	10%	10½— 11½	10½— 11½	10⅝	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	101 —104	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1⅝— 2⅛	1⅝— 2⅛	...	...
49,640	Do. do. do. do. 6 % Pref.	5	...	...	...	4½— 5	4½— 5	...	...
£50,000£	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	96 — 99	96 — 99	...	...
100,000	Metropolitan Electric Supply, 1 to 100,000	10	5 %	6 %	6½%	15½— 16½	15½— 16½	15 15/16	...
£20,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	110 —115	110 —115	...	...
£50,000£	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	99 —102	99 —102	...	...
10,852	Notting Hill Electric Lighting	10	7 %	7 %	6 %	13½— 14½	13½— 14½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	15 — 16	...	...
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
£50,000£	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	1⅝— 2⅛	1⅝— 2⅛	...	...
£0,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
£5,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3	2½— 3	2 13/16	...
110,000	Westminster Electric Supply, Ord.	5	13 %	13½%	10½%	11 — 12	11 — 12	11⅝	...
28,141	Do. do. 5 % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...

* Subject to Founders Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred shares warrants, profits being used as capital.

Dividends marked ‡ are for a year, consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotation Sept. 24th.	Closing Quotation Oct. 1st.	Business done week ended Oct. 1st, 1902. Highest	Lowest.
20,000	British Aluminium 7 % Cum. Pref.	£10	...	5¼%	...	3⅛— 4⅛	3⅛— 4⅛	...	...
£00,000£	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	83 — 88	83 — 88	...	...
100,000	British Electric Traction	£10	8 %	9 %	9 %	12½— 13½	12½— 13½	13⅛	12⅝
100,000	Do. do. 6 % Cum. Pref.	£10	...	...	...	12½— 13	12½— 13	12 13/16	12⅝
£00,000£	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	125 —128	124 —127 xd	125½	124½
100,000	British Insulated Wire Ord.	£5	20 %	15 %	10 %	7½— 7⅞	8 — 8½	...	...
100,000	Do. do. 6 % Cum. Pref.	£5	...	...	...	5⅞— 6	5⅞— 6⅛	5 13/16	...
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	£100	...	...	...	102 —105	102 —105	...	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	8 %	...	13s. to 15s.	13s. to 15s.	...	...
50,000	¶ " " " 6 % Cum. Pref.	£1	...	6 %	...	16/6 to 17/0	16/0 to 16/6	...	...
105,731	Brush Elecl. Engng., Ord., 1 to 105,731	£2	5½%	5 %	Nil	1 — 1¼	¾— 1¼	...	...
150,000	Do. do. Non-cum. 6 % Pref.	£2	6 %	6 %	3 %	1¼— 1⅝	1 — 1½	...	...
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	100 —103	100 —103	101	...
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	93 — 98	94 — 99	...	...
35,000	Callender's Cable Construction shares	£5	15 %	15 %	20 %	15½— 16½	15½— 16½	...	...
40,000	Do. do. 5 % Cum. Pref.	£5	...	...	...	5⅝— 6¼	5⅝— 6¼	...	...
90,000£	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	109 —113	...	...
1,860,014	Central London Railway, Ord. Stock	Stock	...	...	4 %	103 —105	103 —106	105¼	104
494,993	Do. do. 4 % Pref. Stock	Stock	...	...	4 %	106 —108	106 —109	107½	105⅝
494,993	Do. do. Def. do.	Stock	...	...	4 %	103 —106	103 —106	...	...
1,350,000	City and South London Railway	Stock	1½%	1½%	2 %	72 — 74	71 — 73	73	...
85,000	Crompton & Co., Nos. 1 to 85,000	£3	7½%	8 %	7½%	2½— 3	2 — 2½	...	...
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	101 —106 %	101 —106 %	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	£5	6 %	2½%	...	⅛— ⅜	⅛— ⅜	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	£5	6 %	2½%	...	1½— 2½	1½— 2	...	...
£44,023£	Do. do. do. 4 % Deb. Stock Red ...	£100	...	...	...	74 — 78	74 — 78	...	...
100,000£	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	£100	...	...	...	78 — 83	77 — 82 xd	...	...
112,100	Electric Construction, 1 to 112,100	£2	6 %	6 %	6 %	1½— 2	1½— 2	1½	...
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390... ...	£2	...	...	...	2½— 3	2½— 3	2½	...
182,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	99 —102	99 —102	101	100
25,000	General Elec. Co. (1900) 5 % Cum. Pref.	£10	...	5 %	5 %	10 — 10½	10 — 10½	...	...
200,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	100 —103	99 — 102	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	£5	15 %	20 %	20 %	16 — 17	16 — 17	16 1/16	16⅛
35,000	Do. do. do. 4½ % Pref.	£5	4½%	4½%	...	5½— 5⅝	5½— 5⅝	...	...
48,050	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	109 —113	109 —113	109	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	£10	10 %	10 %	...	20½— 21½	20½— 21½	...	...
200,000£	Do. do. do. 4 % 1st Mort. Deb	£100	...	...	...	100 —103	99 —102 xd	...	...
37,500	†Liverpool Overhead Railway, Ord.	£10	3⅛%	3⅛%	1¼%	4⅜— 4½	4 1/16— 4 3/16	...	...
10,000	† Do. do. Pref., £10 paid ...	£10	5	...	...	9⅜— 10¼	9⅜— 10¼	...	...
7,500	Parker (Thomas), Limited, Ord., Nos. 1 to 7,500	£10	...	...	...	14½— 15½	14½—15½	...	...
	§Roaling & Fynn 6 % Cum. Pref.	£1	...	6 %	...	... — ...	19/0 to 20/0	...	...
37,350	Telegraph Construction and Maintenance	£12	15 %	17½%	20 %	38 — 41	38 — 41	38	...
150,000£	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	£100	... %	...	...	102 —105	102 —105	102	...
540,000£	Waterloo and City Railway, Ord. Stock	£100	3 %	3 %	3 %	90 — 93	90 — 93	92½	91

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, ⅞—1⅛.
National Electric Free Wiring, ⅜—1.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 12—14.
Do. do. Pref. (£10 pd.), 10—11.

* From Birmingham Share List ¶ From Manchester Share List.

Bank rate of discount 3 per cent. (February 6th, 1902).

MARKET QUOTATIONS, Wednesday, October 1st.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a " Nitric	per cwt.	29/-	29/-	..
a " Oxalic	per cwt.	29/-	29/-	..
a " Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	42/-	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£38 10	£38 10	..
a " "	per ton	£50	£50	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£18	£18	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a " (50/50%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£19	£19	..
a Lead, Nitrate	per ton	£24	£24	..
a " White Sugar	per ton	£31	£31	..
a " Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C),	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	5d.	5d.	..
a " Caustic (75/80%) ..	per ton	£24	£24	..
a " Bisulphate	per ton	£26	£26	..
a Shellac	per cwt.	109/-	109/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5	£6 5	..
a " Recovered	per ton	£5 10	£5 10	..
a " Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a " Crystals	per ton	£3	£3	..
a " Bichromate, casks ..	per lb.	2¼d.	2¼d.	..
METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b " Wire, in ton lots	per ton	£294	£294	..
b " Sheet, in ton lots	per ton	£191	£191	..
p Babbist's metal ingots.. ..	per ton	£40 to £140	£40 to £140	..
c Brass (rolled metal 9" to 12") basis	per lb.	6¾d.	6¾d.	..
c Tube (brazed)	per lb.	8¼d.	8¼d.	..
c " " (solid drawn) ..	per lb.	7d.	7d.	..
c " Wire, basis	per lb.	7d.	7d.	..
c Copper Tubes (brazed) ..	per lb.	8¼d.	8¼d.	..
" " (solid drawn) ..	per lb.	9d.	9d.	..
g Copper Bars (best selected) ..	per ton	£69	£69	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£69	£69	..
g " Rod	per ton	£69	£69	..
c " Electrolytic) Bars	per ton	£67	£67	..
c " " Sheets	per ton	£74	£74	..
c " " Rod ..	per ton	£67	£67	..
c " " H.C. Wire	per lb.	7½d.	7½d.	..
f Ebonite Rod	per lb.	a/-	a/-	..
f " Sheet	per lb.	5/-	5/-	..
a German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/- to 3/2	3/2½	dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i " Pig (Cleveland warrants) ..	per ton	53/7	53/9½	2½d. dec.
i " Forgings, according to size	per ton	From £11	From £11	..
i " Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i " Wire, galvanised No. 8 ..	per ton	£9 15	£9 15	..
g Lead, English Ingot	per ton	£11 to £11 2 6	£11 to £11 5	dec
g " Sheet	per ton	£13	£13	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 15	£8 15	..
d Mica (in original cases), small ..	per lb.	8d. to 9d.	8d. to 9d.	..
d " " " medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d " " " large ..	per lb.	3/9 to 7/9	3/9 to 7/9	..
p Phosphor Bronze, plain castings	per lb.	11½d. to 1/2	11½d. to 1/2	..
p " rolled bars & rods	per lb.	1/- to 1/8	1/- to 1/8	..
p " " strip & sheet	per lb.	From 1/2	From 1/2	..
e Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	9d. to 1/-	9d. to 1/-	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	From £15	to £40	..
i " " in bars		£58	£58	..
g Tin, block	per ton	£117 to £118	£119 to £120	£2 dec.
g " foil	per lb.	1/6	1/6	..
m " wire, Nos. 1 to 18	per lb.	1/6½	1/7	½d. inc.
p White Anti-friction Metals — "White Ant" brand	per ton	£36 to £60	£36 to £60	..
f Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
f " 6 lea. Flax	per lb.	5½d.	5½d.	..
f " 8 ply 10 lbs. Russian ..	per lb.	5 1/16d.	5 1/16d.	..
f " 10 lbs. Russian, single ..	per lb.	4½d.	4½d.	..
f " 180 lbs. Jute rove	per ton	£11 15	£11 15	..
a Zinc, Sh'ts. (Vieille Montagne brd.)	per ton	£23	£23	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Co., Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons.
e Messrs. Frederick Smith & Co.

Quotations supplied by
f India-Rubber, G.-P. and Teleg. Works
g Messrs. James & Shakspeare. [Co., Ltd.
h Messrs. Edward Till & Co.
i Messrs. Bolling & Lowe.
j Messrs. Walter H. Hindley & Co., Ltd

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd

THE APPLICATION OF ELECTRIC POWER IN THE IRON AND STEEL INDUSTRIES.

By D. SELBY-BIGGE (Newcastle-on-Tyne).

Paper read before the Iron and Steel Institute at Düsseldorf, September, 1902.

(*Continued from page* 561.)

MOTOR TESTS.

Works department or machine.	Work done by motor. Total of machines on motor.	Work done by motor. Usual and average machines on load.	E.H.P. absorbed. Shafting and all machines light.	E.H.P. absorbed. Average machines light.	E.H.P. absorbed. Average machine loaded.	E.H.P. absorbed. Maximum load on motor.	Size and type of motor.
Fitting shop motor.	2-9″ centre lathes. 1-12″ centre lathe. 1-3′ centre chuck lathe. 1 planing machine 9 ft. stroke. 1 slotting machine. 1 milling machine. 1 shaping machine. 1 punch and shears machine. 2-2½″ vertical drills. 1 emery wheel. 1 cold saw (hack). 1 fan supplying nine smiths' hearths. Shafting: 20 ft. × 3 in. c. shaft; 5 others to 10 ft. long.	2-9″ centre lathes. 1-12″ centre lathe. 1-3′ chuck lathe. 1 slotting machine. 1 drilling machine. 1 emery wheel. Fan.	Shafting alone. 1·75 E.H.P. All machines light. 62 E.H.P.	3·7 E.H.P.	9·5 E.H.P.	14·9 E.H.P., with fluctuations, to 19 E.H.P.	20 B.H.P.
No. 1 galvanising house motor.	4 large galvanising pots, each for 20 tons metal. 2 drying machines, attached. 1 large sheet-stretching machine. 1 large corrugating machine (press). 2 circular shearing machines, counter-shafting and belts.	All machines, pots, and drying machine continuous, and others intermittent.	Shafting alone, 1·5 E.H.P.		Average full load, 11·2 E.H.P.	Fluctuation to about 18 E.H.P.	20 B.H.P.
No. 2 galvanising house motor.	1 large galvanising pot. 2 small galvanising pots. (large, 20 tons; small, 10 tons each). 1 drying machine, attached. 1 rolling machine. 1 stretching machine.	All machines, pots, and drying machine continuous, and others intermittent.	Shafting alone, 1·0 E.H.P.		Average full load 6·9 E.H.P.	Fluctuation to about 12·0 E.H.P.	10 B.H.P.
"Dolomite" crusher.	1 9′ diameter pan mill, short counter-shaft.		2·6 E.H.P.		8·2 E.H.P.	11·5 E.H.P., occasionally.	10 B.H.P.
Stamping house motor.	20 stamping machines of various sizes and types, for armature and field-core plates.		6·5 E.H.P.		9·8 to 10·3 E.H.P.	11·0 to 12·5 E.H.P.	10 B.H.P.
Steel charging machine in steel mill.	1 electrically-driven charging machine, charging and discharging, *i.e.*, heating furnaces and supplying live rolls, with ingots up to 10 cwt. each.*		Motor and 1st, 2nd and 3rd motion shafts and gearing, 1·55 E.H.P.	Lifting, 3·2 to 4 E.H.P.; travelling, 7·8 E.H.P.; slewing, 4·9 E.H.P.; racking 5·0 E.H.P.	11·0 E.H.P. 11·0 to 12·8 E.H.P. 6·3 to 8·0 E.H.P. 6·5 to 8·5 E.H.P.	Maximum, when working three motions simultaneously, about 22 E.H.P. under worst conditions.	20 B.H.P.

* Weight of standard billet lifted—10 cwts. (maximum, 12 cwts.). Travelling rails, 6′ gauge; wheels, 2′ diameter. Collector gear = D.P. overhead bare trolley cable, with tramway collecting gear. Travel of peel = 12′ 6″. When peel is racked in towards machine, the distance between centre of bogie and steel billet is approximately 20′, taken radially. When peel racked out is approximately 32′ 6″ from centre of support. Total lift of peel = 3′.

MOTOR TESTS.—*Tests on Cranes, Quick-Motion Overhead Travelling. Taken August 18th*, 1902.

Works Department.	Size and type of travelling crane.	Work done by crane. Average.	Work done by crane. Maximum.	Actual tests on crane. Figures taken August 18th, 1902. Motion.	E.H.P. absorbed. Crane light. Starting effort.	E.H.P. absorbed. Crane light. Running power.	E.H.P. absorbed. Crane loaded. Starting effort.	E.H.P. absorbed. Crane loaded. Running power.	Speeds and loads during test. Actual load.	Speeds and loads during test. Approximate speeds.	Size of motor. H.P. brake or electrical.
No. 1 crane—Plate mills loading.	5-ton 3-motor crane. Works in exposed position, both in and out of shop.*	1 to 3 tons.	4½ tons.	Lifting.	13·4	·5	29·1	18·3	3 tons 6 cwt.	43 ft. per min.	22 E.H.P.
				Traversing.	14·8	7·7	16·8	9·6		125 ft. per min.	15 E.H.P.
				Travelling.	23·6	11·8	29·4	12·6		150 ft. per min.	22 E.H.P.
No. 2 crane—Plate mills floor.	5-ton 3-motor crane. Works under cover.*	1 to 2 tons.	4 tons.	Lifting.	18·0	9·6	27·8	12·8	3 tons 0 cwt.	Speeds approx. as above.	22 E.H.P.
				Traversing.	20·6	9·35	24·5	10·3			15 E.H.P.
				Travelling.	28·5	11·3	34·0	12·4			22 E.H.P.
No. 3 crane (new)—Plate mills loading.	6-ton 3-motor crane. Built and erected by Dowlar's Cardiff Works. Works in exposed position, both in and out of shop.†	1 to 3 tons.	4½ to 5 tons.	Lifting.	22·3	9·5	29·4	19·2	3 tons 6 cwt.	60 ft. per min.	20 B.H.P.
				Traversing.	11·3	6·2	14·9	7·3		150 ft. per min.	20 B.H.P.
				Travelling.	29·5	12·0	32·8	13·8		165 ft. per min.	20 B.H.P.

NOTE.—The starting efforts given above can be regarded only as approximate, being merely momentary and volts drop being disregarded. The cranes above are on 220 volts circuit. One longitudinal trolley wire only employed, the return being to "earth." The above working load tests present a fair and good heavy average load, and are seldom exceeded under actual working conditions in these works.

* This crane has the motors fixed on the main girders above end carriage. Drives by square shaft and gear. Water starting and regulating switch, and metallic lever controlling switch.

† This crane has travel motor on main girders and lift and traverse motors on the bogie. Gear driven. Water starting and regulating switch, and metallic lever controlling switch.

Motor Tests. *Taken August 18th, 1902.*

Description of machine.	Work done by machine.	B.H.P. absorbed.		Type and size of motor.	Remarks.
		Light.	Loaded.		
3-ton skull-breaking winch.	Lifts ball weighing 3 tons 8 cwt. to height of 50 ft. at speed of 60 ft. per min. (timed).	8·5	17·8	2-pole open type armature at bottom, 18 B.H.P., series wound.	This winch is of ordinary band pattern, driven through worm and spur gear, with brakes & clutch. Water starting & regulating switch.

A table of machine tests in a somewhat different form is appended:—

Condensing Plant.—One 10-H.P. motor 220 volts driving direct-coupled 3-in. centrifugal pump, driving also with belt air pump 9½-in. diameter by 9-in. stroke, and feed pump 2-in. diameter by 9-in. stroke. Boiler pressure 200 lbs.

Operation.	Revs.	Amps.	Volts.	Vacuum.	Electrical H.P.	Electrical H.P.
					Total.	Actual per operation
Centrifugal pump.	1,100	6	240	—	1·9	1·9
Ditto with air and feed pump	160	12	240	27 in.	3·8	1·9

Brass-Shop Motor. 5 Horse-Power. 240 Volts.

Operation.	Revs.	Volts.	Amps.	Electrical H.P.	Electrical H.P.
				Total.	Actual per operation.
Motor and shaft... ...	220	250	7·0	2·3	2·3
Disc grinder, 18-in. emery discs running light ...	1,800	246	8·5	2·8	0·5
Facing 6½-in. brass valves	1,800	246	24·0	7·9	5·6
6-in. capstan lathe (light)	—	248	9·75	3·2	0·9
Turning and screwing 1¼-in. brass bars for ⅝-in. tap bolts	—	248	12·0	4·0	1·7
Parting ditto	—	248	10·0	3·3	1·0

Number One Foundry.—Roots Blower, Acme No. M.

Operation.	Revs.	Volts.	Amps.	Electrical H.P.	Electrical H.P.	Time.
				Total.	Average.	
Motor and shafting, light running ...	—	245	14	4·6	—	—
Blowing cupola—						
Maximum ...	360	246	104	32·7	28·2	4½ hours
Minimum ...	350	233	66	21·7		

Total weight of iron melted ... 22 tons 10 cwt.
" " " per hour 5 " 0 "

Number Two Foundry.—Roots Blower, Acme No. K.

Operation.	Revs.	Volts.	Amps.	Electrical H.P.	le rical H.P.	Time.
				Total.	ge.	
Motor and shafting light running ...	—	232	9·5	2 96	—	—
Blowing cupola—						
Maximum ...	430	237	57	17·1	15·94	3 hours
Minimum ...	394	225	50	15·2		

Total weight of iron melted ... 12 tons.
" " " per hour 4 "

Remarks.—Number one cupola is capable of melting on an average 7 tons per hour.

Boiler Shop.

Vertical Plate Bending Rolls.

Length of rolls ... ... 11 ft. 7 in.
Diameter of rolls ... ... 2 1 ft. 11 in.
Mean size of plates rolled ... 20 ft. × 10 ft. 6 in. × 1 in.
Maximum size of plates rolled 16 ft. × 11 ft. 5 in. × 1½ in.

Operation.	Amps.	Volts.	Electrical H.P.	Electrical H.P.	Time.
			Total.	Actual per operation.	
Motor and shaft light running	20	242	6·4	6·4	
Rolls light running ...	24	242	7·7	1·3	
Rolling plate, 23 ft. × 11 ft. 2 in. × 1¼ in. ...	90—68	233	Average. 19·2	12·8	3 min.
Putting squeese on plates	30—60	233	9—18	6—12	
Reversing the rolls ...	50	233	15·6	9·2	

(To be concluded.)

BRITISH ASSOCIATION, BELFAST, 1902.

ON THE PREVENTION OF SMOKE.

By John S. Raworth, M.I.C.E.

(Abstract of paper read in Section G.)

At one time I harboured a great hope that electricity would cure the smoke evil, or, at least, take it right away outside our towns, but that was before the days of the municipal craze, and I did not foresee that Corporations would necessarily plant their works within their own area, and thereby increase the density.

I have endeavoured, in co-operation with my friends, to mitigate the smoke nuisance by promoting electric power Bills, whereby the undertakers would be, and in some cases are, authorised to generate electrical energy in the country, and supply it in bulk to municipalities. It is common knowledge, however, that these Bills were opposed with the greatest possible vigour (not to say acrimony) by the municipalities; it became obvious, therefore, that our local rulers have made up their minds that we shall still continue to live amongst chimneys; therefore, as we cannot convert our rulers, the only way of salvation left is to convert the chimneys. To come to the point: I think I have found a cure for smoking chimneys, viz, the Wilson smokeless process.

The process itself consists in squirting a mixture of air and nitrate of soda solution on the fire. I fitted up a Babcock boiler at Kidderminster, and gave the system a trial. The original installation was both crude and expensive, but it cured the smoke. It had plenty to cure, for the coal in that district is both soft and dirty, consequently the numerous chimney tops emit dense clouds of smoke. The action of the solution of nitrate of soda appears to be somewhat obscure; my theory is that it creates nuclei of intense heat, which fire the gases, and enable the injected air to combine with them. I have had experience with nearly all known methods of smoke prevention; many of them are good, but usually a good stoker can give equally good results without them, the defect of both of them, and the good stoker, is that they diminish the output of the boiler and its thermal efficiency, owing to the fact that they let into the furnace a larger amount of air than is necessary for perfect combustion.

My first desire, therefore, after the success of the Wilson process in preventing smoke had been demonstrated, was to ascertain how it affected the output of the boiler and its evaporative efficiency. For this purpose I instructed Mr. H. Wall Wilkinson, A.M.I.C.E., to conduct a series of tests to ascertain:—

(*a*) The output and efficiency under existing conditions.

(*b*) The output and efficiency under existing conditions with air blast only.

(*c*) The output and efficiency under existing conditions with the complete Wilson process.

The results are given in the appended report, from which it will be seen that assuming existing conditions as 100 (*a*) = 100 plain furnace; (*b*) = 108 air injected; (*c*) = 122 Wilson process.

It is necessary to state that Mr. Wilkinson was entirely sceptical as to the value of the process, and made numerous other tests to satisfy himself that the results obtained were correct. The engineer of the power house was equally sceptical, but when he found that the coal bill was actually reduced, he asked to have all his boilers fitted with the process (which was done). Other instances of the successful application of the process have come under my notice—one at Durham, where the chimney of the power station in the valley disgorged smoke under the windows of houses on the hill side, and another at Windermere, where the electric lighting company was subjected to proceedings in Chancery for nuisance. In this case the smoke was smoke in name only, there was no black smoke, but the process removed the last vestige, and the Chancery suit has been withdrawn.

The Wilson smokeless process is extremely simple—it consists in the injection of a very minute quantity of nitrate of soda in solution into the furnace in combination with sufficient air to produce perfect combustion of the gases. The cost of the nitrate of soda used is from 3d. to 4d. per ton of coal burnt. The system has been installed at the works of Messrs. Gallaher, Belfast. Members of the Association interested in the subject can personally inspect the operation of the process.

Report by Mr. H. Wall Wilkinson, A.M.I.C.E.

March 15th, 1902.

I visited the works of the Electric Traction Company at Kidderminster on May 22nd, 1901, for the purpose of making a series of tests on the Wilson smoke consuming process, the apparatus having been fixed to one of the boilers at those works.

The boiler is a Babcock & Wilcox water-tube boiler having 27 sq. ft. of grate area, 1,218 sq. ft. of water-heating surface, and 142 sq. ft. of steam superheating surface. It is fitted with the so-called Scotch furnace, and works at a pressure of 120 lbs. per sq. in. It was fitted with Meldrum's forced draught apparatus, but this was not used during the tests. The feed water was passed through a Green's economiser on its way to the boiler.

The tests were made on the boiler while performing the ordinary work supplying steam to the traction engines, and the load varied therefore from time to time, and was not the same on all the four days over which the tests continued.

The process consists in forcing jets of air over the surface of the fire, the air carrying with it in the form of spray a solution of the "chemical" supplied by the inventor. The air is introduced through cast-iron blocks built into the furnace walls at the four

corners, the chemical being sprayed in at the two front corners only. Steam jets were used for inducing the supply of air to the blocks. The "chemical" was made into a strong solution and supplied by pipes from an overhead tank.

The coal was "thick slack" from the Hawkins Colliery, Cannock.

On the first day I confined myself entirely to observations on the top of the chimney-stack, carefully noting the difference in the amount and quality of smoke after each firing, both with and without the "process."

When working under the usual conditions, a good deal of dark brown smoke was visible, lasting for about two minutes after each firing. I may here mention that the firing, on the "spread" system, was well and carefully done, about three to four shovels full being put on about every four minutes.

With the process in full operation, a very slight coloured haze was produced, which lasted about 15 seconds after each firing.

With the air jets in operation, but with the "chemical" cut off, there was a very light brown smoke, lasting for about 30 to 40 seconds.

On the second and following days I made a series of evaporative tests both with and without the process, and also a test with air jets only, without the chemical. The results of these tests are appended hereto.

After the test on the first day had commenced, an intermittent leak from the relief valve of the economiser was discovered, so this test was repeated again on May 30th. Every care was used to get as accurate results as possible. The coal was weighed in boxes of 56 lbs. each. The contents of five of these were emptied on the floor at one time, and no more was weighed out until this was all used, the time being noted. The feed-water was measured in two barrels which had been carefully calibrated, and which were emptied alternately into the tank from which the feed pump drew. The fire was cleaned about one hour before commencing the test, and then burnt low. It was cleaned again in three hours after the test was started, and again about one hour before it ended. At the end of the test the fire was burnt low again, so as to bring it to the same condition as at the beginning. The firing was done by the regular stoker employed by the Traction Company. All tests lasted over seven hours.

(Signed) H. Wall Wilkinson.

Summary of Results of Evaporation Tests on Boiler at Kidderminster fitted with the Wilson Apparatus.

Date of Test.	May 23rd (with air and chemical).	May 24th (with air only).	May 25th (ordinary conditions).	May 30th (with air and chemical).
Duration of test ...	7·08 hrs.	7 hrs.	7·42 hrs.	7 hrs.
Average press. of steam	113·3 lbs.	115 lbs.	117·7 lbs.	115·3 lbs.
Average temp. of steam (superheated) ...	469° F.	473° F.	459° F.	466° F.
Average temp. of feed	143° F.	140° F.	146° F.	150° F.
Factor of evaporation	1·228	1·235	1·22	1·219
Total coal	2,856 lbs.	3,416 lbs.	3,248 lbs.	2,744 lbs.
Total coal per hour ...	403 ,,	488 ,,	438 ,,	392 ,,
Total coal per hour per sq. ft. of grate ...	15 ,,	18 ,,	16·2 ,,	14·5 ,,
Total water	19,520 ,,	19,485 ,,	17,680 ,,	17,886 ,,
Total water per hour ...	2,755 ,,	2,784 ,,	2,334 ,,	2,555 ,,
Water evaporated per lb. of coal (actual conditions)	6·83	5·7	5·32	6·52
Do. do. from and at 212° F.	8·38	7·01	6·5	7·95

Note.—An intermittent leak from relief valve of economiser was discovered after the first test was started. It was therefore repeated on May 30th.

H. W. W.

May, 1901.

MAGNETIC DETECTORS IN SPACE TELEGRAPHY.

By Prof. Ernest Wilson.

(Paper read in Section A.)

1. So far as I am aware, Rutherford * was the first to make a scientific investigation into the effect which high-frequency electric currents have upon the magnetism of a bundle of wires previously magnetised. He wound an insulated conductor upon the wires and connected it to a receiver, and found that a magnetometer was affected when electric impulses were received from a distant transmitter. The effect was to demagnetise the bundle of wires. Experiments were made in the Siemens Laboratory, King's College, London, in 1897, the only published note in connection with which is in British specification 30,846, 1897, in which a local varying magnetising force is used during the reception of the electric impulses received from a distant transmitter. It is well known that if iron is taken through a magnetic cycle it is very sensitive to change in the magnetising force when on the steep part of the cyclical curve. This effect is very marked in pure iron,† so much so, that if the magnetising force be varied to a point at which the magnetism is on the steep part of the curve and be then kept constant, a tap will cause it to settle down still further, giving a considerable kick with a ballistic galvanometer placed in a secondary circuit linked with the specimen. To test the effect of high-frequency currents upon magnetism, two experiments may be mentioned—one on hard steel wire 0·025 cm. diameter, the other on iron wire 0·0265 cm. diameter, as received from the draw-plate. Each specimen was wound into a ring having 40 turns, 3 cm. diameter, and supplied with a primary and secondary coil for ballistic galvanometer tests. In addition, each was wound with three turns of stranded copper wire for connecting to a receiver. The latter consisted of a condenser and nine turns of copper wire 4 ft. in diameter in the case of electro-magnetic impulses, and two hard-drawn brass wires in the case of Hertzian waves. The distance between transmitter and receiver was 36 ft. The magnetising force was varied by means of a liquid reverser,*

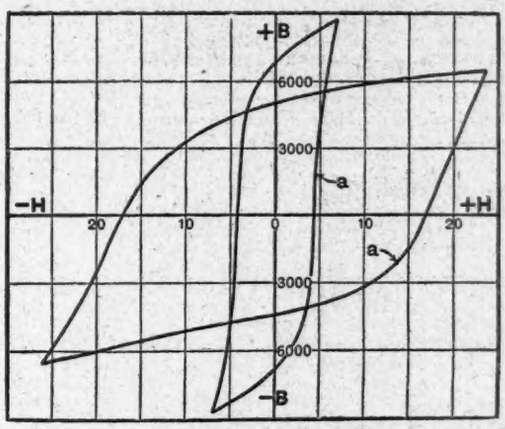


Fig. 1.

and kept steady when on the steep part of the cyclical curve of induction. Fig. 1 gives the cyclical curves for the iron and steel, and the force was varied to the points marked *a* in each case before application of the electric impulses. An apparent acquirement of 14 and 6 per cent. of the maximum intensity of magnetic induction was observed in the steel and iron specimens respectively—that is to say, the kick observed when the magnetising force was finally changed to its maximum value was less after the waves had been applied than it would have been without the application of waves. It is difficult to differentiate between true Hertzian wave effect and that due to electro-magnetic induction, as both were present in the latter case. Probably all the wires attached to the rings helped to receive the impulses. It may be mentioned that the resonating circuit was tuned to the primary, and had a frequency of about $1{\cdot}5 \times 10^6$ periods per second. The values of maximum H in the steel and iron rings were 25 and 6·8, and the maximum values of B were 6,540 and 9,020 respectively.

2. A telephone of 139 ohms resistance was placed in circuit with a coil of 840 turns, and resistance 23 ohms, wound on the steel ring above mentioned. It gave sounds in keeping with the sparks at the

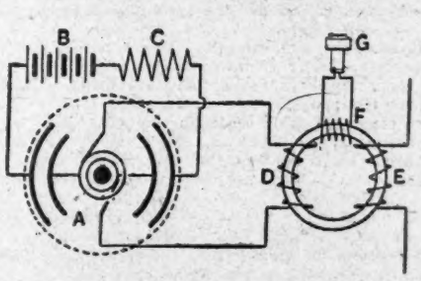


Fig. 2.

transmitter very markedly, when, by means of the liquid reverser, the magnetism was changing along the steep part of the cyclical curve. A diagram of connections is given in fig. 2, in which A is the liquid reverser having copper plates in dilute copper sulphate solution; B is a battery of storage cells with an adjustable resistance, C, in circuit; D is the magnetising coil wound on the experimental ring; E is the coil attached to the receiver, and F is a coil connected to a telephone G. In order that the effects of the variations due to the local magnetising force might be stopped in the telephone, two similar rings had their telephone circuits opposed so far as the changes due to the local magnetising forces are concerned, but helping as regards the magnetising force due to the high-frequency currents. Different values of the maximum intensity of magnetic induction were tried, but it was difficult to say if an intermediate force was better than a larger one. The impression was that iron gave better results than steel.

* *Phil. Trans. Roy. Soc.*, Vol. clxxxix. (1897), A., pp. 1—24.
† *Proc. Roy. Soc*, Vol. xlvi., p. 269, and Vol. lxii., p. 369.

* *Phil. Trans. Roy. Soc.*, Vol. clxxxvi. (1895), A, p. 98.

3. A comparison was made between reversing by aid of an electric current in a magnetising coil and a permanent magnet. Here it must be noted that there may be a difference in the effects obtained by reversing the magnetism in the manner above described, and reversing by rotating a permanent magnet in front of a bundle of iron wires. In the one case the magnetism is reversed by passing through zero, and in the other it is reversed by turning round in a rotating magnetic field. So far as could be judged, there appeared to be equally good results whether the current in a magnetising coil wound on a bundle of iron wires bent into the form of a horse-shoe was reversed; or whether the magnet was brought up to the bundle of iron wires, moved away, reversed, and again brought up; or simply rotated in front of the bundle of wires.

4. To try the effect of submitting the specimen to mechanical stress, a bundle of 50 wires of iron 0·0265 cm. diameter each, was suspended from a wooden frame and wound with a magnetising coil having 22 turns per centimetre in which currents of 1 and ·5 ampere were reversed. A telephone circuit was placed over this. When the wires were stressed to the extent of 7·37 kg. per square millimetre, and at the same time subjected to torsion, the effects in the telephone were increased. Results were obtained with soft nickel wire 1·6 mm. diameter when loaded to 9·76 kg. per square millimetre. It is well known that by submitting nickel to a pull and twist stress the cyclic curve of magnetic induction is rendered very steep, so much so, that the sounds in the telephone due to the local variation of the magnetising force, which were small when not twisted, became very pronounced with a twist of 2° or 3° per centimetre of length.

5. To try the effect of heating, a bundle of 40 wires of iron 0·0265 cm. diameter each, was supported horizontally and connected to a battery of storage cells. The wires were first covered with a layer of asbestos, and wound thereon was an asbestos-covered wire used for the local magnetising current. A telephone circuit was wound above this on another layer of asbestos. The effects in the telephone were very pronounced when the iron had a temperature just below the critical temperature at which it loses its magnetism, and much less pronounced when at atmospheric temperature.

6. All the above experiments were confined to short distances. Mr. Marconi has already achieved wonderful success with rotating magnetic fields in signalling to great distances.

SOME NOVELTIES IN ELECTRICAL APPARATUS.

By M. B. Field, M.I.E.E.

(Paper read in Section G.)

I have the honour of calling your attention to a few electrical instruments which possess, I believe, some novel features. I do not propose to occupy your time by a lengthy explanation of the working of these instruments, but will content myself with stating as briefly as possible what objects they are intended to serve. Detailed explanations may be found elsewhere by anyone who may happen to be specially interested.

Compensated Voltmeter.—This particular instrument is designed for indicating the voltage between either the positive or negative and the neutral main at the far end of a three-wire feeder—that is to say, the voltmeter, although connected to the feeder at the station end, indicates the voltage existing at the network end, being compensated for the feeder drop, no matter how much or how little the network may be out of balance. This instrument is compensated for the drop in a triple-concentric cable 1 mile long, the outers having a cross-section of 0·5 sq. in., the neutral 0·25 sq. in. No pilot wires are employed. The connections are shown in fig. 1. It will be noticed that the two views are identical as regards connections. R_1, R_2 are series resistances inserted in the mains. Two others, shunt resistances, are connected across the mains, the measuring instrument being connected to these shunts so as to divide them up into the four resistances marked 1, 2, 3, 4. The measuring instrument is merely a delicate milli-voltmeter calibrated to read the actual volts at the far end of the feeder. It will be seen that the arrangement corresponds to an unbalanced Wheatstone bridge, where potential differences are introduced into two of the arms proportional to the drop of volts in the outer and neutral mains respectively. A little consideration will then show that the current through the measuring instrument will be proportional to the voltage of the circuit minus a certain multiple of the current in R_1, minus a certain multiple of the current in R_2, assuming the currents are flowing in the directions indicated by the arrows. It is merely a matter of adjusting the ratio arms 1, 2, 3, 4 suitably, in order to get true compensation for the feeder drop of voltage.

In this instrument the resistances are as follows:—

Ratio arm 1.—	10 × 5·6 =	56 ohms.
„ 2.—	99 × 5·6 =	554·4 „
„ 3.—	100 × 5·6 =	560 „
„ 4.—	9 × 5·6 =	50·4 „
R_1 =	·000888 ohm.	
R_2 =	·0195 „	

Hot-Wire Wattmeter.—I have here a hot-wire instrument which, when connected to an electric circuit, will read amperes, volts, true watts, hence power factor, giving readings *consistent* with one another. The drop of voltage across the instrument does not exceed 0·5 volt, so that measurements can be made by it on motors or other apparatus while connected to their normal circuits—*i.e.*, no special provision of higher voltages is necessary when making such tests. The instrument is essentially for workshop and testing-room purposes, *not* for switchboard work. The connections of this particular instruments are those shown in fig. 2. R_1 and R_2 are two alternative non-inductive resistances of different carrying capacities, either of which can be inserted in the main circuit. T is a potential transformer with three secondary windings giving equal voltages. A plug arrangement is attached to the instrument. The first two plug holes (from the left-hand side) give the necessary connections for the determination of watts; the third converts the instrument into a voltmeter; and the fourth and fifth, marked *a* in the figure, into an ammeter, special calibration tables being employed. This instrument is really an outcome of the one previously described; for, with the plug inserted in hole 1, we have practically the same arrangement as the compensated voltmeter modified for a two-wire circuit. Position No. 2 is the same, but with the secondary E.M.F. of the transformer reversed. If the instrument is calibrated to read the square of the voltage at its terminals in each case, the difference of the two readings is a measure of the watts. These instruments may be made up with two pointers moving over the same scale, and with a special attachment for taking both the power readings simultaneously.

Fault Indicator.—This instrument has been designed specially with reference to tramway circuits. As a general rule all feeders for electric tramways are protected by automatic circuit breakers. These not infrequently open from unknown causes. The general practice in tramway systems after a breaker has come out, is to close it again without taking any special precautions. If the breaker comes out three times in succession, the line is reckoned to be short-circuited, and the fault must be searched for. Such a fault may be due to a short-circuit on a car, an earthed guard wire touching the trolley wire, a fallen trolley wire, an insulating bolt supporting trolley wire broken down, &c. The above described method is, of course, crude in the extreme, and the practice of closing a circuit on a "dead short" is often fraught with considerable damage—damage which may only come to light some time afterwards. Now, the resistance of the feeder to earth should be a sufficient guide as to whether the feeder is "shorted" or not. If it be "shorted," the resistance will be well under 1 ohm; if, however, the "short" or overload disappear, the resistance will be fairly high. When the power is cut off any section, the motormen have instructions to at once turn off their controllers, switch on the lights, and wait for these to glow. The resistance to earth will, therefore, be merely the resistance of the lamp circuits. The fault indicator, then, is merely a Wheatstone's bridge where the feeder circuit forms the unknown resistance, the voltmeter on galvanometer and ratio arms being so proportioned that if the unknown resistance is less than 1 ohm, the needle goes hard over to the left, pointing to "Line blocked," and if over 20 ohms hard over to the right, pointing to "Line clear." The general arrangement is shown in fig. 3. A relay may be fitted to the indicator to call attention to the fact that a line is "cleared" as soon as the fault is removed. The instrument may be kept permanently in connection with the positive bus-bar, and plugged on at a moment's notice to any feeder, the breaker of which has opened. To a large tramway system, blocks and interruptions of traffic are most costly, and any instrument which will in any way minimise the duration of these is, I think, worth the consideration of all tramway engineers.

Fig. 1.

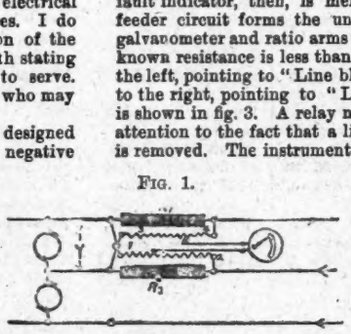
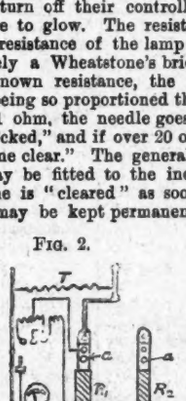


Fig. 2.



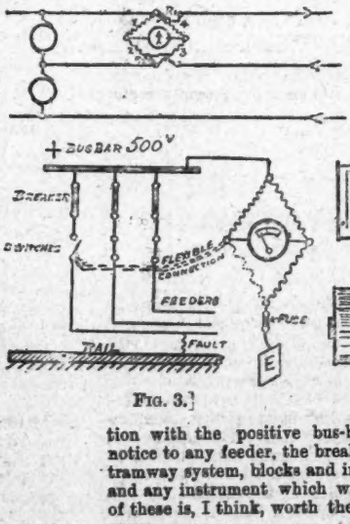
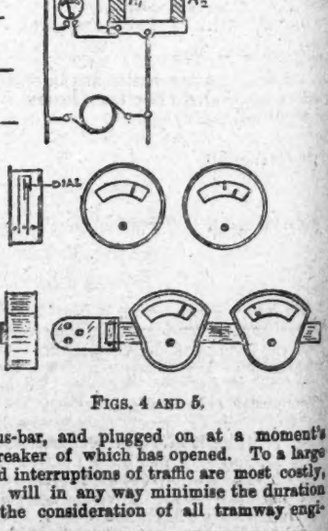


Fig. 3.



Figs. 4 and 5.

Synchronising Gear.—Some engineers prefer synchronising with voltmeters, some with lamps—for myself, I vastly prefer a dead-beat voltmeter. I am, however, very much in favour of installing a set of pilot lamps near the stop valve of each engine, so that the driver can watch the process himself, and open or close the stop valve

intelligently as is required, till paralleling is accomplished. It is, of course, further necessary to adjust the voltage of the incoming machine to equal that of the bus-bars to which it is about to be switched. The object of this synchronising switch is by a *single* setting to establish all the connections necessary for these indications, viz. :—It (1) puts into circuit the pilot lamps on the incoming engine; (2) puts into circuit the synchronising lamps on the panel controlling the incoming generator; (3) puts into circuit the synchronising voltmeter; (4) puts in circuit a special voltmeter which shows at a glance whether the voltage of the incoming alternator is equal to, greater or less than that of the bus-bars (fig. 4). Operation No. 2 may, of course, be dispensed with, for, with a synchronising voltmeter, these lamps are not essential. They are, however, always useful as a reserve method of synchronising. The special voltmeter mentioned in operation 4 is in reality a double one, with two pointers moving over the same dial. One pointer comes up the back of the dial (which is illuminated) and over the top; the other swings in front of the dial. There are no markings on the dial. The one voltmeter is connected to the incoming machine, the other to the bus-bars. If the voltage of each is the same, the two pointers form a radial line across the dial. If the voltages be unequal, the line is broken. The synchronising voltmeter and the above double voltmeter are both mounted on a swinging bracket attached to the switchboard, so that both are in view simultaneously (fig. 5). The synchronising switch itself has some novel features. This one I have here is designed for four alternators. With this switch only four synchronising transformers are needed, one connected to each alternator—that is, the usual auxiliary transformer connected to the bus-bars may be dispensed with. Again, if the dial of the double voltmeter be calibrated, it is really superfluous to supply each generator panel with a separate voltmeter. A synchronising bracket may be fixed at either end of the board, so that in case one instrument breaks down there is always a reserve one. A considerable simplification of the generator panels is thus effected.

ELECTRIC RESPONSE IN ANIMAL, VEGETABLE AND METAL.*

By Prof. Jagadis Chunder Bose, M.A., D.Sc.

(*Abstract of paper read in Section K.*)

The effect of stimulus on living substances is usually detected by two different methods. In the case of *motile* tissues, stimulus causes a change of form. Mechanical response may thus be obtained in contractile tissues like muscles, but in others, like nerves, for example, stimulus causes no visible change. The excitation of the tissue may, however, be detected by certain electromotive changes. The advantage of the electric mode of detecting response is its universal applicability.

Electrical Sign of Life.—The electric response is a measure of the physiological activity of the tissue. When the physiological activity is exalted by a stimulant, the electrical response will rise in amplitude. When the activity is diminished, as by narcotics the electrical response is also diminished. When the tissue is killed, the electrical response disappears altogether. Hence it is said that "the most general and most delicate sign of life is the electrical response." These response-phenomena are considered due to some unknown super-physical "vital" force, and are regarded as beyond the region of physical inquiry. In the present paper it will be shown that this conclusion is not justified; it will be shown that the responsive processes seen in life have been foreshadowed in non-life.

The gap between the animal and metal is very great; an investigation was therefore undertaken on the response in the transitional world of plants. For the demonstration of response I used (1) the so-called method of injury employed by physiologists, and (2) a more perfect method—the method of block—devised by me. For stimulation I used blows delivered by a mechanical tapper. A far more perfect method of stimulation, I find, is by means of vibration. For record of responses the following device is very perfect, and enables demonstration before a large audience. Twin aluminium cylinders are kept revolving at a uniform rate by clockwork, an endless band of paper passing over the cylinders. The moving galvanometer spot of light, at right-angles to the motion of the recording paper, is followed with a pen.

Plant Response, a Physiological or Vital Response.—I have obtained response in all plants, and by all their organs. When the plant is killed by poison or hot water, the electrical response disappears.

Inorganic Response.—The electric response which is regarded as a sign of life, is not confined to living things, but is present in the inorganic bodies as well. Further, the responses in plants and metals are modified by the influence of external conditions exactly in the same way as the responses of animal tissues are modified. There is not a single phenomenon in the response in muscle and nerve that has not an exact parallel in the response of metal and plant. Out of these cases a few were mentioned by the author.†

* A demonstration of electric response of ordinary plants was given by Dr. Bose.

† For a complete account see the following:—

Bose.—"Response of Inorganic Matter to Stimulus," Friday Evening Discourse, Royal Institution, May, 1901.

" "Electrical Response in Ordinary Plants under Mechanical Stimulus."—*Journal* Linnean Society, 1902.

" "Response in the Living and Non-Living."—Messrs. Longmans.

A NEW CO_2 RECORDER.

As was recently stated in our columns, a new CO_2 recorder is being introduced by Messrs. Sanders, Rehders & Co., of London and Manchester. It is termed the "Ados," and is claimed to record autographically and continuously the performance of a furnace, the sole duty of which may very well be said to be limited to the output of a maximum of CO_2 with a minimum of nitrogen.

The operation is as follows:—A certain volume of furnace gas is pumped through the recorder. Part of it is automatically abstracted, measured, and passed through a solution of caustic potash. This absorbs all the CO_2, and the quantity is recorded on a

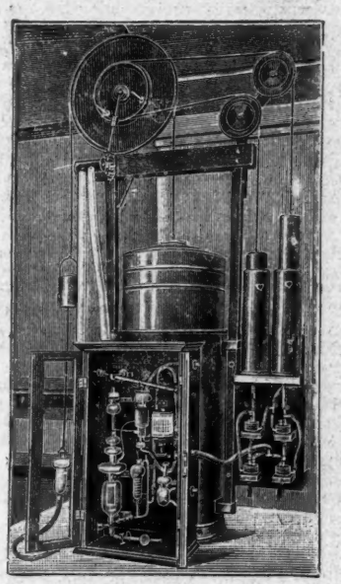


Fig 1.—The Ados Recorder.

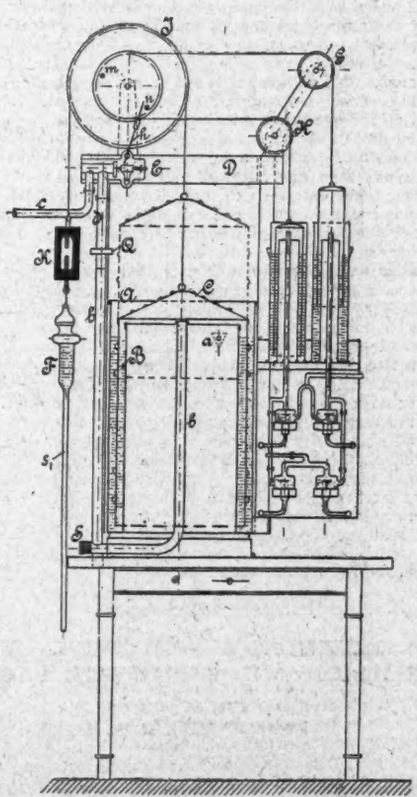


Fig. 2.—Diagram of Ados Recorder.

diagram by vertical lines. The process is repeated about every five minutes, and a curve drawn to touch the top of each vertical line is the curve of percentage of CO_2 in the furnace gas. The apparatus, in fact, analyses the gas as regards the CO_2 present in it.

The instrument consists of a motor, gas pumps, and the analysing and recording apparatus.

The motor is a bell C, alternately connected to the chimney and to the atmosphere by the agency of an automatic valve E. The bell therefore falls and rises, and furnishes the motive power of the instrument, this action recurring about every five minutes.

The bell is so connected as to work a pair of pumps which pump flue gas through the apparatus. It also raises and lowers a bottle of glycerine, F. The gas pumps are simply small open-base cylinders, which dip into oil tanks.

The rise and fall of the bell C works the wheel T, whence cords pass over wheels G and H to work the gas pump bells, and pins m, n, work the lever h, which opens and closes the main bell valve E.

It will be noted that the valves of the gas pumps are simply glass traps or water seals, of sufficient depth to give always a proper resistance proportionate to the intensity of the draught. This instrument will come almost as a shock to old-fashioned gas analysts who have been accustomed to raise and lower the gravity bottle by hand. Manipulation is now put aside by skilfully arranged traps.

The analysing apparatus in the main is a glass tube serving to measure 100 cb. cm. of gas, and a bottle containing the caustic potash solution.

As the bottle of glycerine and water rises and falls, it causes the measuring tube to fill and empty through the space of 100 cb. cm., this measure being imprisoned. The bottle rises further, and forces the imprisoned gas by another pipe into the potash bottle, which absorbs the CO_2, and the potash solution is itself displaced by the unabsorbed remainder. The solution rises into a globe above, and shuts off the escape pipe of this globe; the air imprisoned in the second globe is pushed into a measuring bell, the rise of which moves a pencil-carrying lever, which marks the percentage of CO_2 absorbed. The whole apparatus is scavenged out by the main gas pump, which forces about 20 times as much flue gas through the instrument as is actually analysed. The whole action is, in fact, similar to a very usual way of collecting samples for an Orsat apparatus, in which a mercury bottle slowly collects gas out of a copious stream drawn by a water inspirator.

The instrument is set daily by adjusting it so that when the glycerine mixture is at one given mark the potash solution is at another mark. The potash is mixed to a specific gravity of 1·27, and should last about 120 hours. The apparatus as a whole is most ingenious.

The theoretical maximum of CO_2 in furnace gases is about 21 per cent., but 15 per cent. is the best obtainable in practice, if not really the maximum possible under the theory of mass action. With 15 per cent. of CO_2, the loss of fuel is theoretically 12 per cent. The loss is 15 per cent. when the CO_2 is only present to 12 per cent., and the loss increases as the CO_2 diminishes, until at 2 per cent. of CO_2 about 90 per cent. of the fuel is lost. These figures, of course, refer to ordinary chimney temperatures.

It is only because of the comparative novelty that the automatic analysis of the furnace gas as performed by this apparatus appears at all complicated. A complete analysis would, of course, be somewhat too complicated a problem. Actually, however, the process is simple enough. The chimney draught is made to raise the gravity bottle of the ordinary Orsat apparatus, and the manipulation is replaced by mechanical movements ensured as to accuracy by artfully-contrived traps. Of course, the aim of the instrument is simply to trap off 100 units of gas from a volume of about 2,000 units. The entrapped gas is then sent forward to another trap by way of a bottle which takes out the CO_2, and the space occupied in the second trap is measured and shows how much CO_2 has been absorbed by means of the air volume displaced from the second trap by the gas.

Of course, it is necessary to take care that the potash solution does not become too much charged with CO_2. It must always be kept sufficiently caustic to act promptly. A correct and regular knowledge of the action of a furnace the day through is very desirable, and it cannot better be obtained than by an actual measurement of the CO_2 produced. There may be present some CO even when the CO_2 is low, but this is a point that depends very much on the form of the furnace and the state of mixture of the gases. When mixture is good, there will not be much CO until the CO_2 becomes abnormally high, and if a high value of CO_2 is not accompanied by a poor efficiency in the shape of low duty per pound of coal, there is no reason to worry about the possible small amount of CO that may be present. If, however, high CO_2 and low efficiency co-exist, one may expect imperfect combustion.

We have seen the apparatus at work, and should say that with ordinary care it would prove durable and efficient. Its action is very simple, and its adjustments are easy.

DR. MUIRHEAD'S NEW MODE OF TRANSMISSION AND RELAY FOR CABLES.

By JOHN MUNRO.

The principle of the relay was early applied in telegraphy, and at intermediate stations on landlines good instruments have long been employed for receiving "through" messages from one section and automatically transmitting them, by stronger currents, into the next.

Innumerable attempts have been made to introduce a corresponding apparatus on submarine cables, but, until recently, without success, and their place is usually taken by a clerk, who reads the message as it arrives on one cable, and sends it by hand into the next, or else works a mechanical "perforator" to punch it on a strip of paper, which actuates an automatic sending key.

This manual or "human" translation is a *faute de mieux*, a clumsy expedient, at once laborious and slow, for the speed of sending is limited by the operator, and it is plain that a self-acting relay performing the task at any speed is a great advantage.

Thanks to the sharp, distinct, and forcible character of the signals, it was comparatively easy to devise a relay for land wires. On the other hand, the invention of a relay for submarine cables was one of the most difficult problems in submarine telegraphy. The signals from a long cable are sluggish, feeble, and run together, as in fig. 1, which represents the word "so," at different speeds of sending, as drawn by the siphon of the Kelvin recorder. This wavering line is, in fact, a curve of the rise and fall of the current at the receiving end of the cable. At the sending end the triads of separate currents, positive and negative, which form the signals "s" and "o" respectively, were as distinct, strong, and sudden as those on a landline, but the resistance, leakage, and induction of the cable, as well as the condenser inserted between its receiving end and earth to curb the signals and keep out "earth" currents, have diminished, rounded, and slurred them, as we find. The specimens A, B, C, D, are from the same cable, but the increasing speed from A to D has enhanced the smoothing effect, which, according to Dr. Muirhead, is roughly proportional to the speed of signalling and the KR, that is to say, the product of the total capacity and total resistance of a cable. Note that between successive signals of the same polarity, positive or negative, the siphon does not return to the middle or zero line, but wanders farther from it as the speed is increased, and in the last specimen, D, does not even abide by it between the letters or words. We get, in other words, a shifting or "variable" zero. Now, a serviceable relay for long cables must not only respond to the variations of such weak and wandering currents, but automatically transform them into the strong, decided currents used in sending, and repeat them into the following cable. It should, therefore, be highly sensitive, with its moving parts extremely light, or of small inertia, and, in spite of that, ensure a precise and firm contact in repeating the signals.

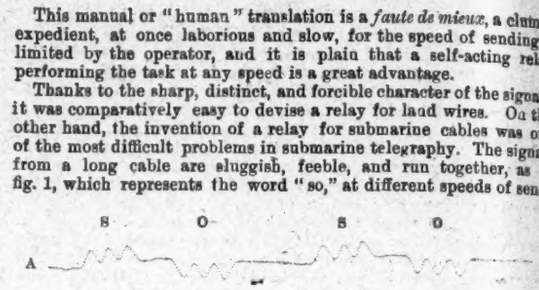


Fig. 1.

This trying and subtle problem is at length solved in a very simple, ingenious and practical manner by Dr. Alexander Muirhead, who, since Lord Kelvin provided the mirror galvanometer and siphon recorder, by his duplex system of working, his automatic sending key, self-induction shunts and other improvements, besides the relay, has done more than any other inventor to promote the art of submarine telegraphy and the interest of the cable companies.

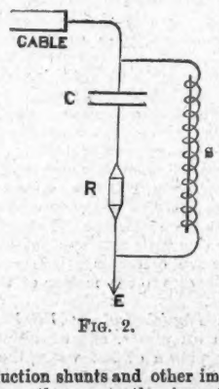


Fig. 2.

Dr. Muirhead has given time to the problem since 1881. The chief difficulty, which baffled so many other inventors, was the shifting zero of the received signals. The end of a cable, as in fig. 2, is generally connected through a condenser, C, and the receiving instrument, R, to earth, E, but the signal currents charging the condenser and working the receiver I soak across the dielectric of the condenser, and vary the zero of the receiver. The automatic sending key or curb transmitter of Dr. Muirhead, patented in 1894, and, on the recommendation of Lord Kelvin, adopted by the Eastern Telegraph Company and its associates, was a remedy for the shifting zero. After sending a current of sufficient power to make a distinct signal on the receiver, this key sends a current of opposite polarity to annul the preceding current in the condenser, curb the signal, and redress the zero line. However, the automatic curb transmitter is not used

on some cables, and it is desirable that a relay should work all round with hand or automatic sending at any speed. Moreover, a curb key applied at one end of the cable to correct an evil at the other is not so convenient as a local remedy adjusted by the receiving operator to his requirements. This Dr. Muirhead found in his inductance or self-induction shunt, patented in 1898 [No. 12,731], which paved the way for a complete solution of the problem. It consists of a simple self-inductance coil, preferably without iron or other magnetic material, shown at S., fig. 2, joined as a shunt or by-pass across the condenser and signal coil of the receiver. The self-inductance of the shunt is adjusted so that the first impulse of a signal current from the cable attains a sufficient strength to make a readable signal on the receiver before the current can flow through the shunt. When the signal current reaches a head or stops, there is a back electromotive force or current from the shunt through the receiver, which has the effect of sharpening the signal and causing a quick return to zero.

Dr. Muirhead first employed the inductance shunt in connection with his well-known "double-block" duplex system of working cables, and he recognised its value at intermediate stations as a "leakage" to relieve the line and facilitate the transmission of signals; but soon afterwards he called it into the service of his new relay.

The siphon recorder of Lord Kelvin had not been overlooked by inventors as a promising basis for a cable relay, but was not without its drawbacks. In it the current from the cable passes through a small coil suspended between the poles of a powerful magnet, and the coil obeying the fluctuations of the current rocks or sways from side to side. A fine siphon spurting ink is attached to the coil so as to delineate its oscillations on a running slip of paper, thus drawing a curve of the rise and fall of the current in the cable, and recording the signals of the message. Although sensitive, the coil has so slight a movement that on using it as a relay to close and open a local circuit good contacts are not easy to obtain. The improved suspension and mode of applying a "directive force" to the coil, as well as the means of discharging the ink by the vibration of the siphon which Dr. Muirhead patented in 1893, have made it somewhat better fitted for the purpose.

In his first patents for a relay on the principle of the recorder (Nos. 516 and 7,525, 1899) Dr. Muirhead utilised these earlier inventions, namely, the new suspension for the coil, the vibration of the siphon or index, and the inductance shunt for curbing the signals, in order to secure firm local contacts. With a sensitive relay where the force making and breaking the local contacts is feeble, the contact pieces are apt to stick together, as electricians know, and to prevent this adhesion, or "stiction," as it is called, Mr. Cromwell F. Varley in 1862, and his brothers, Messrs. Cornelius

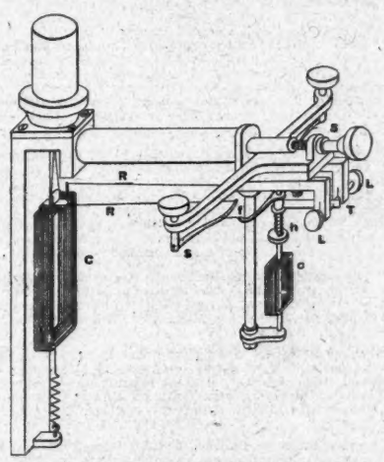


Fig. 3.

and Samuel A. Varley in 1866, patented the device of keeping the contact stops in rotation. This principle of moving contacts is not easy to apply on a delicate relay, but a number of successful adaptations, likely to be useful in other scientific apparatus, have been contrived by Dr. Muirhead for the recorder.

In his "jockey tongue" relay, an early form of the instrument, for example, the tongue or contact lever is kept vibrating between two stops, which are the terminals of the local or transmitting battery. The moving parts of this relay are shown in fig. 3, where C is the signal coil, with the magnets removed, B, B are two reins or filaments from the coil, tightened by the springs S, S, and giving directive force to the coil. A second or smaller coil, C, is actuated from the signal coil, C, by two short fibres from the springs S, S, of which only one, *f*, can be seen. A jockey tongue, T, adjustable by the spring and milled head *h*, is mounted on the spindle of the coil *c*, and is made to vibrate between the limiting stops L, L, by means of an intermittent or alternating current sent through one or the other coil. The tongue is connected to the line or cable, and the stops to the poles of the local battery. Although the tongue is always in a tremor between the stops, the contacts are so rapid that any little current which gets into the cable is quickly absorbed, and it is only when the tongue has a bias, or is pressed for a time against one or the other stop by the movement of the signal coil, that signal currents are sent into the cable.

The vibration of the jockey tongue between the stops is, however, not merely to prevent stiction. It has the still more important function of bringing the tongue back to zero.

Another novel plan for correcting the shifting zero is described in the same patents. It consists of a derived circuit, possessing retardation, which taps a portion of the outgoing current from the line battery, or a separate local battery, and sends it through a special winding on the signal coil. This derived current, or "overflow" circuit, as he calls it, being always of opposite polarity to the signal current in the coil, and of sufficient strength for the purpose, tends to urge the coil back to zero.

On very long cables the successive signals of one polarity lose their distinction (see D, fig. 1) and coalesce into a single wave. Such a long deflection of the signal coil actually represents three separate signal currents at the transmitting end of the cable, and in relaying it the local battery must send three short currents instead

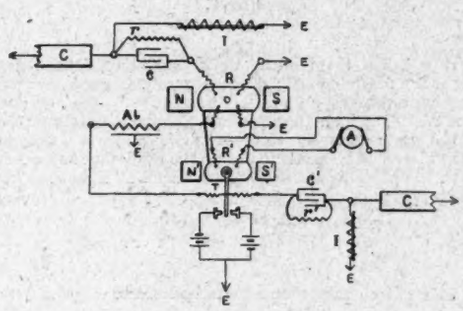


Fig. 4.

of one long current into the next cable. To this end Dr. Muirhead and Mr. H. A. C. Saunders, in 1881, patented (No. 1,624) an electrical method of splitting up such long waves into the corresponding number of short signals when relaying them. M. Louis Maiche, in his patent (No. 9,846, 1886), has given a mechanical apparatus for doing the like. The retarding "overflow" device just mentioned also enabled Dr. Muirhead to accomplish it in more than one way by means of his artificial cable, or a combination of condensers and resistance, or self-induction coils.

In 1899 a "jockey tongue" relay, with an "overflow" circuit, was installed at Malta. Fig. 4 is a diagram of it, where *c* is the receiving condenser, R the signal coil of the relay between the poles, N S, of its magnets, and E the earth. An inductance shunt, I, is connected across the condenser and receiver to earth, and an ordinary resistance, or non-inductive shunt, *r*, across the condenser. The second coil of the relay, R′, between the magnets, N′ S′, is actuated from the signal coil, R, by the arrangement shown in fig. 3, and is vibrated by the current from an alternator, A, flowing through it. The jockey tongue vibrates with it between the terminals of the local battery, and is connected to the following cable through a condenser *c*, shunted by a resistance *r*′, with an inductance coil I to earth.

There is also an "overflow" circuit from the tongue through a section of artificial line, A L, and the signal coil to earth. This "overflow," combined with the inductive shunt, has the effect of curbing the coil, overcoming the variable zero, and giving a neat, "square" form to the signals.

After these different steps in the progress of the relay, Dr. Muirhead took a long stride forward. The cumbersome retardation or "overflow" circuit to curb the movements of the signal coil, and the elaborate contrivances for splitting up the prolonged waves into

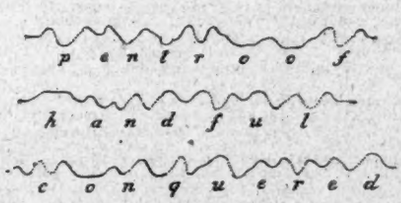


Fig. 5.

short signals on the local circuit, were discarded. The relay, delivered from these complicated accretions, a source of trouble in practice, became very simple, workable and fit. He achieved this great reform by a new form of transmission.

When a long cable is worked at a high speed the waves representing signal currents are, as we have seen from fig. 1, sluggish and indefinite. Separate signals of each letter, which ought to appear as ripples, are obliterated, and the zero line between them is not straight. Dr. Muirhead sharpens the signals and straightens the zero line, as in the specimens, fig. 5, received at Porthcurnow, England, all the way from St. Helena, on the West Coast of Africa, with a single relay at St. Vincent repeating 86 letters a minute. The K B is about 5½ for the Porthcurnow to St. Vincent and about 6½ for

St. Vincent to St. Helena section. This is done by providing a complete conductive circuit from the earth at the sending end of the cable to the earth at the receiving end. The arrangement is shown in fig. 6, where C is the sending condenser, shunted with a low resist-

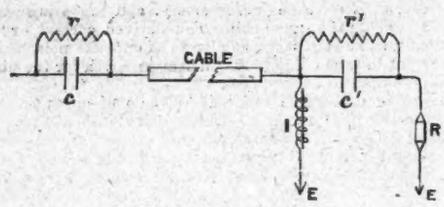


Fig. 6.

ance, r, adjusted to give the right amount of deflection to the signals at the receiving end; C' is the receiving condenser shunted with a high resistance, r'; I is an inductance by-pass or shunt to earth E, which, by its high self-inductance and low resistance, drains away the ground current from the cable, and gives a straight zero line, but allows the signals to charge the condenser and deflect the receiver, R, producing the shapely or "square" signals, as they are called by operators.

(To be continued.)

NEW PATENTS, 1902.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

20,097. "Improvements in storage batteries." W. O. Rooper. September 15th.

20,112. "A method of winding electric machines." H. Rottenburg. September 15th.

20,168. "Improvements in, or relating to, electrical induction or sparking coils." F. H. Hall. September 16th.

20,199. "Improvements in or connected with the construction of electric arc lamps." J. Brockie. September 16th.

20,206. "Improvements in switches for starting and controlling electric motors." J. Eck. September 16th.

20,230. "Improvements in electric switch signals." C. P. Bass and T. B. West. September 16th. (Complete.)

20,237. "Improvements in selective calls for telephones and telegraphs." W. Palmer, Jun., and A. McClintock. September 16th.

20,240. "Improvements in electric conduit railways or tramways." R. A. Hadfield and D. Galbraith. September 16th.

20,259. "An improved electric hand-lamp for use on railways, tramways, ships, and other places for signalling." V. Connor. September 17th.

20,265. "Improvements in or applicable to trolley poles of electrically-propelled vehicles." A. Lumbers. September 17th.

20,280. "Electrical insulator." M. Harloe. September 17th. (Complete.)

20,289. "Improvements in telephone systems." D. Macadie. September 17th. (Complete.)

20,323. "Improvements in and relating to electric switches." L. B. Codd. September 17th.

20,334. "Improvements in protecting irons for electric cables." L. Mannstaedt. September 18th. (Complete.)

20,340. "Improvements in the form and construction of wire used for the transmission of electrical energy." I. Hopkinson. September 18th.

20,376. "An improvement in telephonic microphone transmitters." O. Imray. (W. E. Knoff, Brazil.) September 18th.

20,425. "Improvements in or in connection with cut-outs for overhead electric traction or trolley wires." W. Towler. September 19th.

20,456. "Improved portable testing and comparing instrument for electric incandescent lamps." A. McCandlish. September 19th.

20,488. "Improvements in electric car trolleys." J. W. Knowles. September 19th.

20,445. "Improvements in terminals for electric wires." The Wolseley Tool and Motor Car Co., Ltd., and H. Austin. September 19th.

20,456. "Quick break chopper-switch for high voltage currents, with automatic spark extinguisher." O. Volkmann. September 19th. (Complete)

20,461. "Improvements in detachable connections for use in electric lighting and heating." A. P. Lundberg and G. C. Lundberg. September 19th. (Complete.)

20,483. "Improvements in electric safety fuses." O. L. Peard and F. Dew. September 19th.

20,502. "Automatically operated points and cable connections for main junctions of electric tramways and the like." C. G. Goord. September 19th.

20,552. "Improvements in electric switches." I. G. Waterman. September 20th. (Complete.)

20,553. "Improvements in electro-magnetic valve controlling apparatus." I. G. Waterman. September 20th. (Complete.)

20,555. "Improvements in electro-magnets." I. G. Waterman. September 20th. (Complete.)

20,556. "Improvements in electro-magnetic valve-controlling apparatus." I. G. Waterman. September 20th. (Complete.)

20,571. "Improvements in and connected with alternate current motors." V. A. Fynn. September 20th.

20,572. "Improvements in or connected with alternate current motors." V. A. Fynn. September 20th.

20,573. "Improvements in or connected with electro-magnetic clutches or couplings." V. A. Fynn. September 20th.

20,587. "Improvements in safety arrangements for use in electric motor and other circuits." The Johnson Lundell Electric Traction Company, Limited. (R. Lundell, United States.) September 20th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1900.

13,656. "Improvements in and relating to the electrodes of accumulators and the manufacture thereof." H. W. James. Dated July 30th, 1900. Relates to the manufacture of electrodes which consist of a central supporting core enveloped in active material.

13,765. "Improvements in automatic electric block systems for railroads." J. Sheperaft and C. E. Gardiner. Dated July 31st, 1900. Relates to signalling, &c., between trains; semaphore signals. The semaphore signals are operated automatically, being put to "danger" at both ends of a block section when a train enters that section, and to "safety" when the train leaves the section. 6 claims.

13,805. "Improvements in insulating supports for electrical conductors." G. Wright. (C. Aalberg, U.S.A.) Dated August 1st, 1900. Relates to the construction of supports and insulators for conductors, especially at the back of telephone switchboards. The insulators are provided with central openings, and have annular recesses and projections, so as to allow of being assembled on a bolt. The conductors are held in position in the lateral grooves where two insulators are placed side by side. The brackets are arranged with bosses to fit into the underside of the insulators. 3 claims.

13,810. "Improvements in and connected with trolleys for electric traction having three wires for three-phase or other currents." H. Gerard. Dated August 1st, 1900. Relates to electric railways and tramways with single or triphase currents on overhead or underground conductors. Conductors: Three wires are held at the points of an equilateral triangle, all being insulated if three-phase currents are used, or one wire may be uninsulated to serve as a guide. The wires may be carried overhead or in a conduit. Collectors: A four-wheeled frame runs on the two bottom wires and a spring-pressed arm carries a fifth wheel bearing under the top wire. The wheels on the two sides are insulated from each other and from the top wheel, and are connected by leads to the vehicle motors. 3 claims.

13,811. "Improvements in or relating to contact boxes for electric railways and tramways." H. T. Hillischer. Dated August 1st, 1900. Relates to electric railways and tramways on a road contact system with switches operated by magnets on the vehicle. 3 claims.

13,816. "Improvements in or connected with storage batteries." W. O. Rooper. Dated August 1st, 1900. The connection of a set of plates of one polarity to a common conducting bar as so arranged that they can be readily separated from one another to enable them to be straightened or otherwise repaired, and so that corrosion is prevented. 5 claims.

13,820. "Improvements in or relating to starting switches and automatic controllers of electro-motors." E. F. May and P. H. Beatie. Dated August 1st, 1900. A starting switch for motors is so arranged that the handle may be removed directly to its stop, but the resistances are only cut out slowly. A locking arrangement is provided, which is released in case of a under or overload, and a spring return the switch to the "off" position. 7 claims.

13,839. "Improvements in glow bodies for electrolytic incandescent lamps." B. M. Drake and Nernst Electric Light, Limited. Dated August 2nd, 1900. Filaments are made from paste of refractory material, of flat, oval, rectangular, star or pinion section in order to have surfaces larger in proportion to their surface areas. They are hardened by a passage through an electric arc. 2 claims.

13,860. "Improvements in controllers for electric motors." T. T. Perkins. Dated August 2nd, 1900. Motor controllers are fitted with blow-out magnets with specially arranged shields between the contacts. One pole-piece is connected to the cores of the magnets by arms, and the back of the casing forms the other pole-piece. Refractory plates are arranged around the drum. Between the contact-fingers are fitted shields secured to the plates. In the shields are embedded steel plates. One plate being brought near the pole-piece and another plate near the back of the casing. These plates direct the flow of magnetic flux, and blow out the arc. The reversing switches and the drums are connected by interlocking mechanism as usual. 2 claim.

13,873. "Improvements in electric switches." G. H. Whittingham. Dated August 2nd, 1900. A rod to which the bridging contacts are indirectly connected is normally held in its lowest position by a weight. When an electro-magnet is energised, the lower end of its armature engages with a constantly rotating pinion, and the rod is raised to separate the contacts. The armature is normally held away from the magnet by a spring plunger. The contacts are carried by a framework embracing the rod, and a spring is interposed between one of the cross-pieces and a collar. 4 claims.

13,874. "Improvements in automatic electric circuit controllers." G. H. Whittingham. Dated August 2nd, 1900. Relates to automatic circuit controllers more particularly for opening or closing the circuit of an electric motor driving an air or gas compressor when the pressure of the air or gas reaches a certain higher or lower limit. 8 claims.

13,892. "Heating bodies for exciting electrical incandescence bodies made of second-class conductors." V. F. Fenny. (Allgemeine Elektricitats Gesseischaft.) Dated August 2nd, 1900. Auxiliary heaters for incandescence bodies are made by winding platinum, nickel or other wire on thin rods of kaolin porcelain, magnesia, fireclay or other fire-proof material, and the rods are formed into coils. 4 claims.

13,901. "Improvements in electrical demand indicators." A. Wright, J. R. Dick and Reason Manufacturing Company. Dated August 2nd, 1900. A maximum indicator consists of a strip of wire tube, or other body of iron, copper or other material, and an acid or other liquid capable of attacking it, the strip being moved to the liquid or the liquid moved to the strip; by the action of the meter, the extent of such movement being subsequently shown by the length of strip dissolved or corroded, or the loss or gain of weight of the strip or the liquid. The materials are perfectly such that a little time is necessary for the attack to have much effect. The invention may be applied to any kind of electric meter having a moving part, for example, those described in Specifications No. 588, A.D. 1893; No. 5,451, A.D. 1895; No. 3,409, A.D. 1896; and No. 10,496, A.D. 1898. 2 claims.

13,951 "Improvements relating to electric muffles or furnaces." J. Weiss. Dated August 3rd, 1900. A resistance furnace applicable for use in dentistry consists of a muffle having a flanged mouth and wound with platinum wire which is heated by passage of currents. The muffle is placed in a somewhat larger space in a casing formed in halves to permit access to the heating wire, but held together for use by a frame and clamping screw; one half carries terminals. 1 claim.

13,962. "Improvements in electric signal registering systems for telephonic systems." C. A. Jenson. (Yungae Signalphone Manufacturing Co.) Dated August 3rd, 1900. Relates to automatically signalling the number of a station on an exchange and recording the same when the subscriber has taken the receiver off the hook. 2 claims.

13,970. "Improvements in armatures for dynamo-electric machines." British Thomson-Houston Company. (C. P. Steinmetz, U.S.A.) Dated August 3rd, 1900. To obtain a large starting torque and high efficiency under normal load, the armature, or induced member of an induction motor, is provided with two or more independent windings, one at least of which is of the squirrel-cage type, and of comparatively high resistance. At starting, only the squirrel-cage winding is closed; but, as the motor gathers speed, the other windings are successively closed. Part of a toothed armature having the conductors of a distributed winding inserted between the teeth and bars of a squirrel cage winding embedded in grooves at the ends of the teeth, so as to be in close inductive relation to the inducing winding. 7 claims.